THE

JOURNAL

OF

SCIENCE AND THE ARTS.

THE

JOURNAL

OF

SCIENCE AND THE ARTS.

EDITED AT THE ROYAL INSTITUTION
OF GREAT BRITAIN.

PUBLISHED QUARTERLY.

VOL. V.

LONDON:

PRINTED FOR JOHN MURRAY, ALBEMARLE-STREET,
BY W. BULMER AND CO. CLEVELAND-ROW, ST. JAMES'S.

1818.

45655
September 28, 1944

Eng.
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TO CORRESPONDENTS.

We regret, that the Political and Statistical Table of the United States of America came too late for Insertion.

The experiments contained in the communication from Great Totham seem to want repetition; their publication therefore has been deferred.

G. C. H.'s Observations on the Arabic Digits, with his permission, in No. XI.

F. M.'s Astronomical Observations have not reached

ERRATA.

Page 85, line 16, for *radices*, read *radius*.
165, 21, for 03,5 read 32,5.
166, 6, omit the comma after atoms.
30, for 700,000 read 100,000.

PREFACE.

In terminating the second year of their labours, the Editors of this Journal proceed, consistently with the plan which they formerly announced, to draw a retrospective outline of the progress of those principal branches of Science and Art, which properly belong to the object of their work; and if it be found that during the last twelvemonth no very brilliant discoveries have been added to the general stock, it will nevertheless, be allowed to have been enriched with many useful and important inventions, and to have received a considerable increase of facts and observations. Although therefore the march of science has not been rapid, it has been sure, and we have nothing to apprehend from those retrograde movements which are apt to succeed too rapid strides.

Regarding the Philosophical Transactions as the standard of English Science, we shall first notice the contents of the volume for 1817, and afterwards advert to the novelties which have been brought before the public by other channels of information, and from other sources.

Among the chemical papers, Sir Humphry Davy's researches on flame obviously stand fore-

most; they not only contain many new philosophical facts, and tend to elucidate some recondite chemical phenomena, but what is of more importance, they develope principles applicable to the purposes of common life; among them are those upon which the security of the miner's lamp depends, and which we have elsewhere frequently adverted to. The question, what is flame? is for the first time satisfactorily answered in this paper. It is aëriform matter, heated so highly as to be luminous; and when luminous, its temperature is considerably beyond that which is commonly called a white heat; so that air may be made hot enough to impart a white heat to solid bodies, and yet not become luminous itself; as may be easily shewn, by holding a piece of thin platinum wire over the chimney of an Argand lamp fed with spirit of wine, or even by the common expedient of lighting a piece of paper, by exposing it to the current of hot air which rushes out of a common lamp glass. Such being the nature of flame, it is further obvious, that if we cool it by any means, we must at the same time extinguish it; and this is accordingly done, by passing it through the metallic apertures of fine wire gauze, or any other substance which has considerable conducting and radiating powers in regard to heat, or which, in other words, is capable of producing a *cooling* effect. So a piece of wire-gauze placed in the centre of the flame of a candle, cuts it as it were in half, the upper part being

extinguished by the cooling power of the gauze, while the lower part remains luminous, because of a temperature sufficiently high.

The power, therefore, of a metallic or other tissue to prevent explosion, will depend upon the heat required to produce the combustion as compared with that acquired by the tissue; and the flame of the most inflammable substances, and of those that produce most heat in combustion, will pass through a metallic tissue that will interrupt the flame of less inflammable substances, or those that produce little heat in combustion; so that different flames will pass through at different degrees of temperature.

It fortunately happens, that the fire-damp of coal mines requires a very high temperature for its inflammation, and, consequently, even a coarse tissue will have sufficient cooling powers to prevent its explosion, and security is proportionally easily attainable.

That flame may be extinguished simply by *cooling*, Sir Humphry ingeniously shews, by putting a coil of cold platinum wire close to a small flame of a spirit lamp: it goes out in consequence of the heat carried off by the wire; which is not the case if the wire be previously heated: or to descend to a more common illustration—when we blow out a candle, the extinction of the flame is produced by the cooling power of the current of air projected into the flame, and the hottest flames are least easily blown out.

There is therefore nothing mysterious, recondite, or difficult to be understood in the operation of the safety lamp. The flame being sur-surrounded by wire-gauze, nothing can enter or pass out of the cage in a state of inflammation; and when the fire-damp gets in, it burns without being able to communicate with the exterior inflammable atmosphere.

Another interesting subject discussed in this paper, relates to the nature of the light of flames, and their form. When pure gaseous matter is burned the light is very feeble, and the density of a common flame is proportional to the quantity of solid charcoal first deposited and afterwards burned. The flame of pure hydrogen is pale blue, and emits very little light; but if we throw into it metallic filings, small pieces of platinum wire, powdered charcoal, or any other solid matter, its light becomes increased by the ignition of this extraneous addition. It is precisely thus with the flames of candles, lamps, and carburetted hydrogen, or as it is now emphatically called, *gas*. The inflammable element is pure hydrogen; the whiteness and intensity of the light being produced by a quantity of ignited carbonaceous matter given off by the decomposition of the inflammable matter, and heated white hot. The form of flame is conical, because the greatest heat is in the centre of the explosive mixture. In looking stedfastly at flame, the part where the combustible matter is volatilized is seen, and it

appears dark, contrasted with the part in which it begins to burn; that is, where it is so mixed with air as to become explosive. When the wick becomes clogged with charcoal, it cools the flame by radiation, and prevents a proper quantity of air from mixing with its central part; hence the charcoal thrown off from the top of the flame is only red hot, and much escapes unconsumed.

The facts stated by Sir H. Davy, in the first section of this paper, show that the luminous appearances of shooting stars and meteors cannot be owing to any inflammation of *elastic* fluids, but must depend upon the ignition of solid bodies. Dr. Halley calculated the height of a meteor at ninety miles; and the great American meteor which threw down showers of stones, was estimated at seventeen miles high.

The velocity of motion in these bodies must in all cases be immensely great; and the heat produced by the compression of the most rarified air from the velocity of motion, must be probably sufficient to ignite the mass; and all the phenomena may be explained, if *falling stars* be supposed to be small bodies moving round the earth in very eccentric orbits, which become ignited only when they pass with immense velocity through the upper regions of the atmosphere, and if the *meteoric* bodies which throw down stones with explosions be supposed to be similar bodies containing combustible or elastic matter.

There is another paper of Sir H. Davy's in this volume of the Philosophical Transactions, explaining the singular phenomenon of the ignition of metallic wires in inflammable gaseous mixtures. Thus if a fine coil of platinum wire be heated and introduced into an explosive atmosphere of coal gas, it becomes red hot, and continues so till the gas is burned; affording an instance of combustion at a temperature sufficient to ignite the wire, but insufficient to inflame the gas. A whimsical application of this fact is exhibited by putting a small coil of platinum wire round the wick of a spirit lamp, which when heated becomes red hot, and remains so as long as the vapour of the spirit is supplied; the heat never becoming sufficiently intense to produce its inflammation. Sir H. Davy proposes to improve the safety-lamp by placing a coil of platinum wire within the cage above the flame, which will thus continue to give light in atmospheres so foul as to extinguish flame, and will only cease to be luminous when the air is unfit for respiration.

We cannot take our leave of these curious, new, and interesting researches, without expressing our surprise and indignation at certain piratical attempts which have lately been made upon our author's grand discovery of the safety-lamp; or rather, at the misguided zeal with which some persons have been willing to support such perfectly unwarrantable claims.

In this volume, we are glad again to see the

name of one who has formerly contributed largely to the celebrity of the Chemical department of the Philosophical Transactions. We allude to Mr. Hatchett's description of a process for the complete purification of musty corn: it is extremely simple, and practice has proved it effectual. The corn is put into any convenient vessel capable of containing at least three times its quantity; the vessel is then filled with boiling water, the grain occasionally stirred, and the hollow decayed grains, which float, are to be removed; in half an hour the water may be drawn off, the corn rinced with cold water, drained, and kiln-dried.

The remaining chemical contributions to this volume relate to a new fulminating platinum discovered by Mr. Edmund Davy, and to an astringent vegetable substance from China, which was sent to Sir Joseph Banks, who entrusted its examination to Mr. Brande. It proved to be a species of galls, containing little else than tannin and gallic acid; hence excellent for black dye and writing ink, but less proper for the purposes of the tanner.

It is to be regretted that many useful and probably abundant productions of distant countries, and even of our own Indian possessions, are scarcely known in this country, while many less useful articles of consumption are abundantly imported, because habit has sanctioned the sub-

stitution. The same observations, are much more applicable to several manufactures of the East, which deserve to be scientifically investigated, and of which the principles would, no doubt, be most importantly applicable at home; but in one way or other these matters have been strangely neglected, principally in consequence of the deficient education of those whose opportunities have been most extensive.

Comparative Anatomy, and Physiology, constitute important features in the volume of the Philosophical Transactions for 1817; and there are no less than seven valuable communications on these subjects from the pen of Sir Everard Home. Of most of these we have already given abstracts in other parts of this work. They are illustrated by some of the most beautiful engravings which we ever remember to have seen, from the admirable drawings of Mr. Clift, and Mr. Baüer. The skill of the former as an anatomical draughtsman has been long known; he possesses the talent of transferring to paper the complicated appearances of dissected parts, with more truth and accuracy than any of his predecessors whose works we have had occasion to examine. Mr. Baüer's labours have hitherto been chiefly, if not entirely confined to botanical subjects, and the exquisite productions of his pencil which enrich the cabinet of the President of the Royal Society, who has long patronised his talents, are well known to many

of our readers. We are glad to see his peculiar abilities brought to bear on the illustration of animal physiology.

Of Dr. Johnson's account of the common leech, and Mr. Todd's experiments on the torpedo, we have elsewhere spoken; and the results of Mr. Wollaston's experiments with his *Thermometrical Barometer* for measuring altitudes we have communicated, (Vol. iii. p. 372, of this Journal.)

We have occasionally noticed Dr. Wilson Philip's physiological Researches, which he has now embodied and published in his "Experimental Inquiry into the Laws of Vital Functions, &c." The last volume of the Philosophical Transactions contains a paper of his "on the Effect of Galvanism in restoring a due action of the Lungs:" he recommends this remedy in cases of habitual asthma or asthmatic dyspnæa; in inflammatory cases however it has proved injurious, and in cases connected with dropsy or other mechanical impediments it has turned out inefficient.

The remaining paper on comparative anatomy, is "*on the Genus Ocythoë* of Rafinesque, with a description of a new species," by Dr. Leach; of which, and of Dr. Davy's paper on the temperature of the ocean and atmosphere, we have given some account in our Quarterly Reports of the Proceedings of the Royal Society.

A paper by Sir W. Herschell, "*on the Arrangement of Celestial Bodies in Space, and on the*

Extent and Condition of the Milky Way," and two papers by the Astronomer Royal "*on Parallax,*" which have recently been rewarded by the Parisian Academicians with Lalande's Gold Medal, conclude the list of communications printed by the Royal Society, with the exception of a long French communication on Ship Building by M. Dupin, and the following on Mathematical subjects:

A paper entitled "*Observations on the Analogy between the Calculus of Functions and other Branches of Analysis,*" by Charles Babbage, Esq. M. A. F. R. S.

Several singular analogies are pointed out, one of which relates to a method of solving functional equations by a process very similar to that employed by Euler for the solution of differential equations, by means of a factor, which renders the equations integrable. In the application of this, however, to functional equations, some difficulties occur, which still require elucidation.

"*Two general Propositions in the Method of Differences.*" By T. Knight, Esq.

The two propositions here treated of, are to determine the n^{th} difference, or n^{th} integral of a function of any number of quantities whose differences are variable. The method pursued by Mr. Knight is sufficiently simple, considering the complicated nature of the formulæ investigated. It might however be rendered still more concise,

by employing the elegant device of Arbogast, of separating the symbols of operation from those of quantity ; thus the expression:

$$u^n \frac{d^n \varphi(x,y)}{dx^n} + \frac{n^{n-1}u^{n-1}}{1} w \frac{d^n \varphi(x,y)}{dx^{n-1}\, dy} + \&c.$$

which Mr. Knight denotes thus:

$$\Sigma\left(\frac{d^n \varphi(x,y)}{d^{n-m} dy^m}\right) \boxtimes (u+w)^n$$

would be very naturally represented by

$$\left(u\frac{d}{dx} + w\frac{d}{dy}\right)^n \phi(x,y)$$

and similarly in other instances.

This author does not appear to be aware of the admirable work which contains this artifice of notation, the Calculus of Derivations ; in it, if we mistake not, (see Art. 409), he will find a theorem much more comprehensive than the two which he has demonstrated, and which, in fact, contains them, but it is treated by different principles.

A paper by T. Knight, Esq. " *on the Construction of Logarithmic Tables.*"

The author proposes to give instructions for the formation of a table of logarithms to any number of decimals. These will undoubtedly be found useful, when the increased accuracy of experimental inquiry shall have rendered necessary more extensive tables than those in common use ; and there is an uniformity in the plan that Mr. Knight has pointed out, which has not been very prevalent in the instructions generally given for this purpose. In the mean time it is much to be

regretted that the immense tables calculated under the direction of M. Prony have not yet been given to the world. It is now about twenty years since this vast labour was accomplished, and we have but lately heard of an intention of publishing an abridgement of them to eight places of decimals; and even this appears to depend on the chance of finding a number of subscribers to defray the expence of publication. Even in this reduced state they would be a valuable present to the mathematical world, as from the methods taken to insure their accuracy, they would form a criterion by which the accuracy of the common tables might be ascertained.

This volume also contains a note from Mr. Knight, in which he acknowledges that the proof he had given of the binomial theorem, and which the Royal Society inserted in the volume of their Transactions of the preceding year, had been invented and published by Mr. Spence about six years before; and he makes the same acknowledgement with respect to the first theorem in his paper on the construction of logarithmic tables, which we have already noticed as appearing in the present volume.

The very learned and ingenious gentleman who has thus anticipated the results of Mr. Knight, is now no more; he was one of the very few of our countrymen who cultivate the higher departments of mathematical science; intimately acquainted with the present state of that science, he devoted

himself with ardour to extend its boundaries; and the successful result of his early efforts furnished abundant cause to regret the premature termination of a career of originality and genius. His mathematcal papers have been examined by Mr. Herschell, and some, which are sufficiently complete, are in the course of publication; amongst these will be found a paper *on the Integration of some Equations of finite Differences*, of very considerable difficulty.

One of the most important additions to mathematical literature during the past year, is a *New Explanation of the Theory of Imaginary Quantities*, by B. Gompertz, Esq. It is a subject which has always been considered as involved in considerable difficulty, although the accuracy of the results obtained by their means has never been disputed. The mode of reasoning pursued by Mr. Gompertz is peculiarly delicate and refined, and to those who are sufficiently advanced in these studies to appreciate its force, it is perfectly convincing.

We shall not attempt to abridge this explanation, which would lose considerably by being deprived of the illustrations with which it is so ably supported. We cannot, however, forbear noticing the singular connection which Mr. Gompertz has shown to exist between the doctrine of imaginary quantities, and one of the most beautiful and interesting branches of geometry, *the subject of porisms*.

The mechanic arts in this country have already

reached so high a degree of perfection as to render them, in many instances, almost incapable of improvement; hence, their advances cannot be expected to be so rapid and brilliant as the branches of chemical science, which, as it is developed, is constantly affording new facilities to the man of science, as well as the manufacturing artist. Considerable advances have, however, been made in this department since the first appearance of this work, and the Editors trust that they will not be accused of inattention to this most important branch of British improvement, since they have taken occasional opportunities of introducing accounts of such objects as came to their knowledge, and which seemed most particularly deserving of public attention.

Among the most prominent of the mechanical improvements which we have now to notice, is the dry process of preparing and husbanding Flax, of which a particular account is given in our present volume, and which appears to hold out material advantages to this nation.

The typographic art has not only been improved and facilitated, but this improvement has been extended to several articles connectod with it; and the ingenious application of machinery and steam to the process of printing, as practised at the Times newspaper office, and in a more improved state at the printing-office of Mr. Bensley, cannot fail to excite astonishment at the rapidity with which the work is performed.

The new and ingenious printing press of Mr.

Donkin, the revival and introduction of the lithographic art, or printing from stone, and the improved process of printing in colours without plates, and the use of inks without oil or any material which may discolour the white of the paper, as proposed by Mr. Savage, all possess important advantages.

Mr. Didot has likewise materially improved and simplified the process of producing paper in continuous sheets, or cutting it into any size or form.

Among the manufacturing processes, that of weaving has received some important improvements, particularly from that most ingenious artist and manufacturer Mr. Heathcoat, of London, who was the first to contrive effective machinery, which should imitate with precision all the intricate motions of the lace maker upon the pillow, and produce a fabric in formation similar to that of foreign lace, and scarcely to be distinguished from it. He has since so far improved his machinery, as to introduce the *gimp* or pattern upon it in the first instance while weaving: nor is his machinery confined to the production of one breadth at a time. He has since directed his attention to that most valuable machine, the stocking frame, and now produces several pairs at once, by a process nearly similar to that which originally produced but one web. Mr. Mersey's new process for weaving coach and livery lace is also highly worthy of notice, as producing a fabric from the

same materials, which far exceeds in beauty any thing which had preceded it.

The manufacture of woollen cloth in this country has likewise been carefully attended to, and has received some valuable improvements, not only in the growth and preparation of wool, but likewise in the finishing processes called shearing and gigging, by the machinery introduced by Messrs. Lewis, Price, Colliers, and others, in Gloucestershire.

The easy and safe conveyance of passengers and goods, by roads and navigation, is an object of the first importance in a commercial country, and one particularly deserving of attention. The benefits arising from canal navigation, are already sensibly felt in every part of the kingdom, and from the attention which has for some time past been paid to propelling vessels by steam, and the many improvements which have been proposed in its application, there is every reason to hope that it will be as effectually used in canals and at sea, as in rivers; and in a future Number, when some of these new expedients have stood the test of experience, we shall offer some remarks on those which appear the most efficient. Several machines have likewise been presented to the public for amending and repairing roads.

London has within the last few years to boast the acquisition of two new Bridges: the light and elegant iron structure of Vauxhall, erected under the direction, and from the design of

James Walker, Esq., and the magnificent granite bridge of Waterloo, which as a piece of modern masonry is perhaps unrivalled in the world. The more stupendous iron bridge of Southwark is making rapid progress towards completion, under the directions of John Rennie, Esq., and will probably be finished before the close of the present year; while the patent lately obtained by Captain Samuel Brown, R. N., may perhaps be the means of producing an effort of art almost beyond imagination, since he proposes to construct a bridge of chains formed of long bars of iron, the central opening of which will be 1000 feet, and the lateral ones 500 feet each; and his deductions are drawn from experiments conducted so carefully, to leave no doubt of the possibility of carrying this grand scheme into execution.

The progress which the illumination from coal gas is making, not only in the metropolis, but in various provincial towns, and the perfection to which the apparatus is now brought, cannnot be considered among the least of the improvements of the present day.

To these may be added, the improvements in fire arms, derived from the patents of Messrs. Manton, Paulli, and Sartoris, the latter of whom have applied the heat obtained from the condensation of air, to fire the charge, instead of flint and steel. Adie's alteration of the barometer, by which it is rendered completely portable; the improvement of Bramah's lock, by which the most

perfect security is obtained; the kaleidoscope of Dr. Brewster, for assisting the imagination of artists, in producing regular forms in a manner almost magical; and many other articles, which want of room, rather than of inclination, obliges us to pass over in silence.

Having said thus much concerning the scientific novelties of the year, we might refer to a multitude of important facts, discoveries, and inventions which have been brought before the public by periodical writers; but as our object is rather to form a general estimate than to enter into particular details, and as we are necessarily limited in this place, we pass over much in silence, and refer our readers to our own pages* and those of our colleagues and contemporaries, for the ma-

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* We trust that the plan of the miscellaneous article in the present Number will be approved of. We propose that it should present a quarterly retrospect of the subject it embraces, consisting partly of original experiments, and intelligence; partly of such gleanings from daily and monthly publications as are thought worthy of being more permanently recorded. These it is intended to arrange under the following heads:

I. MECHANICAL SCIENCE.
Abstract Mathematics.
Mechanics, Astronomy.
Optics, Pneumatics.
Hydrostatics, Acoustics, &c.
Architecture.
Mechanical Manufactures.
———— Agriculture.

terials which fill up the outline and complete the sketch we have given.

For the same reason we have abstained from remarks upon the progress of the sciences abroad, where they have been diligently cultivated, and more especially in the capital of the French empire.

To revert more immediately to ourselves, we trust that our own pages, as well as those of other works, bear testimony to the activity of the ROYAL INSTITUTION, and that the various courses of instruction, which under the direction of the Managers of the Establishment, are annually

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II. CHEMICAL SCIENCE.
- Chemistry.
- Meteorology.
- Electricity.
- Magnetism.

III. NATURAL HISTORY.
- Zoology.
- Botany.
- Mineralogy.
- Geology.
- Anatomy.
- Medicine.
- Surgery, &c.

IV. GENERAL LITERATURE, FINE ARTS, AND MISCELLANEOUS SUBJECTS.
- Literary Intelligence.
- Antiquities.
- Painting.
- Sculpture.
- Engraving.
- Ornamental Arts.

delivered within our walls, are calculated to sustain the reputation of the School, and the credit of the Professors.

If the patronage bestowed be considered as bearing a relation to the merits of our exertions, we begin to perceive grounds of solid satisfaction. Though our zeal and activity were never blunted by the alarming apprehension of pecuniary embarrassment, with which we were once assailed, it still operated in many respects as a repulsive power to the well wishers of the establishment, and gave an apparent sanction to the weak inventions of our enemies. From these we are now relieved, partly by the accession of new members, of whom a list is annexed, and partly by a donation from John Fuller, Esq., of Rose Hill, who has contributed the interest of the sum of ONE THOUSAND POUNDS to the general purposes of the INSTITUTION; and upon conditions couched in terms of unbounded liberality, has proffered the capital either towards the immediate extinction of our very small outstanding debt, or for the foundation of a sinking fund.

It is hoped that such an example of well directed bounty may prove generally useful to the interests of science, and that funds will not be wanting, wherever it shall be shewn that they are not frittered away in visionary schemes, but legitimately applied to the diffusion of knowledge; that they are not suffered to slide into the pocket of the sinecurist, but economically employed for the public good.

List *of* Members *elected into the* Royal Institution *in the year* 1817.

John Hambrough, Esq.
Thomas Hoblyn, Esq. F. R. S.
Thomas Jeans, Esq.
Samuel Parkes, Esq. F. L. S.
George Moore, Esq.
Frederick Hodgson, Esq.
John Dyneley, Esq.
Sir W. Burroughs, Bart. M. P.
Samuel P. Wright, Esq.
Anthony Bertolacci, Esq.
Major W. C. Holloway, Royal Engineers.
Lieutenant Colonel John Baillie, F. R. S.
Oliver Farrer, Esq.
Captain Thomas Coleby, Royal Engineers.
William Stewart Rose, Esq.
James Goding, Esq.
Charles Robinson, Esq.
Alexander Copland, Esq.
Augustus Bozzi Granville, M. D.
Robert Williams, Esq. M. P.
Lieutenant Colonel Ansley.
Jeremiah Olive, Esq.
Ashurst Majendie, Esq.
C. P. Mayer, Esq.
Thomas Roberts, Esq.
Jesse Watts Russell, Esq.

LIST OF BOOKS PRESENTED TO THE LIBRARY OF THE ROYAL INSTITUTION IN THE YEAR 1817.

1817.		DONORS.
Jan. 27.	Collectanea ad Statum civilem et ecclesiasticum Comitatus Dunelmensis, 4to.	Geo. Allan, Esq. M. P. M. R. I.
	A View of the Agricultural, Commercial, and Financial Interests of Ceylon, 8vo. By Anthony Bertolacci, Esq. M. R. I.	The Author.
	The Institutions of Physiology, by J. F. Blumenbach, 8vo.	John Elliotson, M. D.
	Le Vray et Methodique Cours de la Physique resolutive, par Annibal Barlet, 4to.	Edward Brooke, Esq.
	Transactions of the Geological Society, vol. iv. part 1. 4to.	The Geological Society.
	The 39th Report of the Society for Bettering the Condition of the Poor.	The Society.
Feb. 17.	Essays on Hypochondriacal and other Nervous Affections, by John Reid, M. D. 8vo.	William Luxmore, Esq. M. R. I.
	G. Biagioli, Tesoretto della Lingua Toscana, 8vo.	The Author.
Mar. 3.	Curiosities of Literature, vol. 3. by J. D'Israeli, Esq.	The Author.
	Essays, Religious and Moral, by Isaac Hawkins Browne, Esq. 8vo.	General Thornton, M. P. M. R. I.
10.	Two Sketches of France, Belgium and Spa, in two Tours during 1771 and 1816, 8vo.	The Author.
	A Genealogical Chart of the Kings of England.	Mr. Richard Mitchell.
17.	Outlines of Geology, by W. T. Brande, Professor of Chem. R. I. &c.	The Author.
	Sketch of a Plan for a Reformation in the System of Provincial Banking, 8vo.	The Author.
April 14.	Cursory Remarks on a Bill for Regulating of Mad-Houses, by G. Man Burrows, M. D. F. L. S. &c.	The Author.
	A Narrative of Occurrences in the Indian Countries of North America, since the connexion of the Earl of Selkirk with the Hudson's Bay Company, 8vo.	The Author.
27.	Transactions of the Horticultural Society, 4to.	The Horticultural Society.
	A Treatise on the Records of the Creation; by John Bird Sumner, M A. 2 vol. 8vo.	Isaac Hawkins Browne, Esq.
	Arguments in favour of the practicability of relieving the able-bodied Poor, and finding employment for them, by Sir Egerton Brydges, Bart. M. P.	The Author.
	Essai General d'Education Physique, Morale, et Intellectuale, par M. A. Jullien, de Paris, 4to.	The Author.
May 5.	An Inquiry into several Questions of Political Economy, applicable to the present state of Great Britain, by Anthony Bertolacci, Esq. M. R. I.	The Author.
12.	Algebra, with Arithmetic and Mensuration, from the Sanscrit of Brahmegupta and Bhascara, 4to.	Henry Thomas Colebrooke, Esq. F. R. S. &c. &c.
	The Statutes of the Realm, volumes 2 and 3. folio.	His Majesty's Commissioners of the Public Records.
	Fœdera, *new edition*, vol. i. 2 parts.	
	Domesday Book, vol. iv. and Supplement.	
	Inquisitionum ad Capellam Domini Regis Retornatarum, vol. 3, and Supplement, folio.	
	A New System of Commercial Arithmetic for Monies, Weights, and Measures, by Thomas Preston, 12mo.	The Author.

1817.		DONORS.
May 26.	Design for a bridge over the River Mersey, at Runcorn, to connect the Counties of Chester and Lancaster.	Thomas Telford, Esq. F. R. S. E.
June 16.	M. De Pradt on the Colonies, and the present American Revolutions, 8vo.	The Publisher.
	Herbarius; sive Aggregator practicus de Simplicibus, *cum figuris*, 4to. *c lit. antiqua.*	Earl Spencer, President of the R. I.
July 7.	The 34th Volume of the Transactions of the Society of Arts, Manufactures and Commerce.	
	Mr. Arthur Aikin's Address at the Distribution of Rewards by the Society of Arts, &c.	The Society of Arts, &c.
	Remarks on the Construction of Hot Houses, by J. C. Loudon, F. L. S. 4to.	The Author.
	A New System of practical political Economy, with Engravings of the Hydrostatic Ship.	The Author.
Aug. 4.	Philosophical Transactions for 1817, Part I.	The Royal Society.
	A Parallel drawn between the two intended Chinese Dictionaries, 4to.	The Author and Editor.
	The Colonial Journal, No. 5 and 6.	The Editor.
	A Dissertation on the Structure of the Obstetric Forceps; with several new Forms, by R. Rawlins, Surgeon, Oxford.	The Author.
	Remarks on Arsenic, considered as a Poison and a Medicine, by John Marshall, Surgeon.	The Author.
Septr. 15.	Chemical Amusement; Instructive Experiments in Chemistry, by Frederick Accum, 12mo.	The Author.
	An Essay on the nature of Heat, Light, and Electricity, by Charles Carpenter Bompass, Esq. 8vo.	The Author.
	Transactions of the Geological Society, Vol. IV. Part 2.	The Geological Society.
	The Principles of Diagnosis, by Dr. Marshall Hall, 8vo.	The Author.
19.	Narrative of Mr. James Sadler's Aerial Voyage across the Irish Channel, Oct. 1, 1812, and of Mr. Windham Sadler's, July 22, 1817.	Mr. John Sadler.
24.	An Essay on the Chemical History and Medical Treatment of Calculous Disorders, by Alexander Marcet, M. D. F. R. S. M. R. I. &c. 8vo.	The Author.
	The Geneva Catechism, prepared by the Pastors of Geneva, for the Swiss and French Protestant Churches, 12mo.	The Revd. Dr. Abauzit.
Oct. 20.	Valor Ecclesiasticus temp. Henr. VIII. Vol. 3, folio.	His Majesty's Commissioners of the Public Records.
	A Letter on the Measures of the Medical Officers of the London Eye Infirmary, by Sir W. Adams.	The Author.
	Lusus Naturæ Londini, observatis, descriptus, Tabula et Notis insuper illustratus, à B. De Sanctis, M. D.	The Author.
Nov. 3.	A Letter to Professor Stewart, on the objects of general Terms, and on the axiomatical Laws of Vision, by John Fearne, Esq.	The Author.
10.	Six Letters on Singing, by the Revd. C. J. Smith, A. M.	The Author.
	Observations on the Phenomena of Insanity, by Thomas Forster, F. L. S.	The Author.
Decr. 1.	Observations on the origin of Decorative Architecture, by Samuel Ware, Esq. F. S. A. M. R. I.	The Author.
	Archaeologia, Vol. XVIII. Part 2.	The Society of Antiquaries.
	Philosophical Transactions, for 1817, Part 2.	The Royal Society.

1817.		DONORS.
	Transactions of the Horticultural Society, Vol. II. Part 6.	The Horticultural Society.
5.	An experimental Inquiry into the Laws of the Vital Functions, by A. P. Wilson, M.D. F.R.S. E. 8vo.	The Author.
	Case of the Salt Duties; with Proofs and Illustrations, by Sir Thomas Bernard, Bart. M. R. I.	The Author.
	Observations on the Gaol or Typhus Fever, by Sir G. O. Paul, Bart.	The Author.
	The European Magazine for 1817.	Mr. Asperne, the Publisher
	The Repository of Arts, Literature, &c. &c.	Mr. Ackerman, the Publisher

A Collection of Swedish Minerals has been presented to the Institution by Professor Swiedenstiernha.

Mr. Dowson of Welbeck-street has presented and fixed one of his excellent Door Springs to the News-paper Room.

THE QUARTERLY JOURNAL

OF

SCIENCE AND THE ARTS.

ART. I. *On the Origin and Vicissitudes of Literature, Science, and Art, and their Influence on the present State of Society: being a Discourse delivered on the opening of the Liverpool Royal Institution, by* WILLIAM ROSCOE, *Esq.*

THIS Discourse is upon a subject intimately connected with the object of our Journal, and our readers cannot be displeased that we lay before them some extracts from a composition, distinguished by the justness of its views, and by the various erudition with which its accomplished author has adorned and illustrated his arguments and positions. It is not, indeed, to be expected, that much novelty will be found in the discussion of topics, upon which so many writers have displayed their reasoning and learning, and with which so many volumes have been filled. The merit of this performance, when divested of the interest arising from its ornaments and style, consists in having separated from the results of mere conjecture, some conclusions, that may be safely relied on, as furnishing maxims and directions for the progressive improvement of the arts and sciences, and in marking perspicuously the circumstances, that most frequently accompany their prosperity or decay. Unfortunately, some of the causes which have operated from the remotest periods most extensively, and in ways the most evident, to impede the progress, to hasten the decline, or finally to obliterate the vestiges of our

improvements, are little subject to the control of human wisdom, and all experience teaches us, it is more to be expected they should be mitigated in their violence, or at times suspended, than wholly extinguished. Other causes, of a partial nature, and more in the power of governments or individuals to suppress or bring into activity, which are supposed to promote, and which appear at different stages of the history of mankind and in various combinations of social order, to have assisted in the extension of our knowledge, have not always proved so decisive in their effects, as to afford undoubted rules to guide our steps.

The signal success of the people composing some of the Greek republics, in their attempts to perfect the arts and sciences, and the unquestionable proofs they have left of their advancement, have induced many writers to investigate the causes which animated the genius, and excited the energies of that extraordinary race, to reach the excellence they attained. The free nature of their governments, and their public institutions, are supposed to have served as the foundation of this acknowledged eminence; yet to the republics such eminence was not exclusively confined. It may indeed be doubted, if the history of antiquity has transmitted to us materials sufficient to determine with certainty, how far such causes operated to produce the benefits ascribed to them; or to what extent they received assistance from other motives, well known to awaken exertion. The tastes, opinions, prejudices, private habits, and the various relations of individuals in a nation to each other, are not frequently recorded by the historian, and can be but imperfectly collected from works written professedly to instruct us on such points: yet, upon their tendency to encourage or depress the progress of knowledge, must the fate of literature and the sciences much depend. Even at periods not far distant from our own times, and in states of society subject to our personal inspection, how difficult it appears to distinguish the combinations of circumstances and events, which accelerate or retard the march of our improvements, or estimate the real value of schemes and plans, which

have been anxiously matured by wisdom and experience, to rouse or direct the genius of a nation.

Notwithstanding the difficulties in which these questions are involved, some conditions are indisputably established, as requisite under all forms of government, to ensure the prosperity of literature and science. To their developement Mr. Roscoe has directed his attention; and, fortunately, they appear in all respects conducive to the happiness and interests of mankind. We consider this part of his Discourse, and that in which he demonstrates the indissoluble connection of literature and science with the exaltation of our species and the stability of society, to be the most important; and we must refer such readers, as are unwilling to lose the benefit of ingenious suggestions on the origin of the arts in remote antiquity, to the work from which we shall make the extracts.

Mr. Roscoe prefaces this part of his Discourse, from which our extracts are made, with the just remark, that it must be thought extraordinary, that when mankind have once arrived at a high degree of improvement, and by long and unwearied exertions have divested themselves of the shackles of ignorance, they should again be liable to fall into a state of debasement, and to forfeit those acquisitions, which required such an effort of genius and of labour to obtain; and that it might reasonably have been presumed, that when letters and arts had arrived at a certain eminence, they would only have to look ardently forwards towards higher degrees of improvement. Experience, however, affords a perpetual proof, that this is not the condition of our nature; even when knowledge and taste have been interwoven with the very manners and habits of the people, they have, in a short time, been obliterated and lost. If we may trust a very popular opinion, the energies of nature have, from the earliest records of society, been continually declining, and the productions of her later years can stand in no degree of comparison with those of her vigorous youth. Another opinion, in direct opposition to this dispiriting idea, would induce us to believe, "that the human race is in a regular and progressive course of improvement,

and that every age of the world is more enlightened than that which preceded it; but the experience of past ages does not allow us to conclude, that such progressive improvement is the characteristic of the human race: and we must dismiss the idea that there is, in the human mind, any inherent tendency towards either improvement or deterioration.

"It has been strongly insisted, that one of the causes which has contributed to the vicissitudes of literature and sciences is, the diversity of climate, and local situation. There are countries, it has been observed by an eminent French writer, where the inhabitants have never received the first rudiments of improvement, and he conceives he can exactly ascertain within what degree of the equator such countries lie; but it requires no very extensive acquaintance with history to discover, that the progress of letters and arts is not restricted by rivers and mountains; and that such is the constitution of man, that in many instances the facility of success deadens the desire of it, and the obstacles which he encounters only serve to give a keener edge to his exertions.

"Some have supposed that the sciences and arts contain within themselves the principles of their own destruction, and when they have arrived at their highest excellence, they, in the course of human affairs, perish and decay. This effect has been accounted for, by imagining it is occasioned by overstrained refinement, or a desire of excelling those who may be considered the just standards of taste. But such observations contain little more than the statement of facts, in which we must all agree; but still the question must recur to what cause this decline of liberal studies is to be attributed. It may, with confidence, be asserted, that neither literature nor art have attained their highest degree of perfection: and the causes of this alteration, therefore, must be sought in some essential changes in the condition and manners of a people, which degrades their dignity, perverts their moral character, corrupts and extinguishes their taste. This is illustrated, by comparing the state of Rome, when the style of Cicero had attained such a degree of excellence, with the period when a

decline in the art of oratory took place, and the change that occurred in Italy, in the beginning of the sixteenth century, when the independent states of that country fell under the dominion of despotic princes, and the free and vigorous mode of composition, that distinguished the revivors of learning, gave way to an affected and enervated manner; till, with their independence, and strength of character, the people lost that truth of feeling, and correctness of taste, which can be permanently established on no other foundation. Having established, that we are to seek for the vicissitudes in the fate of literature and the sciences, in the unceasing operation of moral causes, in the relations of society, and the disposition and propensities of the human mind, we find one of the most important of these relations to be, that by which we are connected with the government under which we live. That the enjoyment of civil liberty is indispensable to the cultivation of literature, is an opinion that has been very generally advanced; and that in a despotic monarchy, where the people are governed as slaves, it is impossible they can aspire to any refinement of taste or reason. But although this sentiment, in various forms, and in various modifications, has been often asserted, this has not deterred others from avowing a contrary opinion, and produce the age of Louis the Fourteenth as as period of high civilization, and distinguished literary excellence. Yet this improvement was not the result of a free government, but the spontaneous growth of a country, which had long been a stranger to political and civil liberty, and which even gloried in its subjection to despotic control.

"In attempting to decide on these opposing facts and discordant opinions, it may, in the first place, be observed, it is not on the professed, or nominal form of a government, on which its aptitude or inaptitude to the promotion of literature depends. A jealous, or suspicious government, locks up and deadens the energies of the people. All governments derive their support from public opinion; and when any government, whatever its denomination be, is firmly established, it can admit of a degree of liberty in its subjects, which might

be supposed to be injurious or fatal to unsettled authority. According to the degree of confidence which any government has in its own stability, will, in general, be the liberty allowed to the expression of the public sentiment, and in proportion to this liberty will be the proficiency made in literary pursuits. Nor must this freedom of opinion and expression be confined to particular subjects. Debarred of expatiating at large on those important subjects which involve the regulations of society, in politics, in morals, in manners, and in religion, the human faculties become contracted, devoted to minute and trivial discussions, and unable to operate with vigour and effect, even upon those subjects which are permitted to their research.

"It has therefore seldom been in the power of an absolute monarch, to afford a degree of literary liberty equal to that which the people enjoy under a mixed or popular form of government; and with whatever liberality it may be granted, being the bare concession of the sovereign, it is neither so certain in its duration, nor so extensive in its effect, as that which is founded on right, and defined by known and established laws. In a government legitimately constituted, the freedom of enquiry and expression is a permanent principle, interwoven with the existence of the state; in an absolute monarchy it is temporary and accidental, depending on the character and will of the prince, and may be suppressed or extinguished, whenever he may conceive that his interest or his safety requires the adoption of such means.

"There is a striking distinction between a despotic and a popular government, as applied to the improvement of the human mind; in the former, as the administration of public affairs is concentrated in an individual, who is jealous of any interference in the exercise of his authority, a large field of enquiry is shut out from the investigation of the people, when the chief encitement to exertion is the hope of those favours and rewards, which the sovereign may think proper to bestow; but in a state, which partakes of the nature of a popular government, the path to distinction, to wealth, to honour, and

importance, is open to all, and the success of every individual will, in general, be in proportion to his vigilance and talents. The studies of literature are only a reflection, or shadow, of the transactions of real life; and he who is a stranger to the hopes and fears, to the passions and emotions, which agitate the mind in the affairs of the world, will only repeat the ideas of others, but will never attain that originality and strength of thought, which is only derived from close examination, and long observation of real life.

"Among the external causes that deaden the operation of the intellect, and destroy the vital principle of exertion, few have been more effectual than a state of public insecurity, and a long continuance of desolating wars. The circumstances in which all Europe was placed, during the middle ages, when, for a long course of time, one species of desolation was followed by another, in quick succession, and the world was thinned in its number by pestilence and famine, the sword exhibited too certain a cause of the deep debasement of the human mind, and of the almost total relinquishment of liberal studies. In the arrogant estimation of brutal strength, wisdom and learning are effeminate and contemptible; and when those qualities are little esteemed, the attainment of them will no longer excite exertion.

"It then appears that a state of general tranquillity, and a government that admits of a free exertion of the mind, are indispensably necessary to intellectual improvement. It would, however, be in vain to expect, that the arts and sciences should flourish, to their full extent, in any country where they are not provided, or accompanied by a certain degree of stability, wealth, and competency, so as to enable its inhabitants occasionally to withdraw their attention from the more laborious occupations of life, and devote it to speculative enquiries, and the pleasures derived from the works of art. Whenever any state has allowed this enviable preeminence, and enjoys also the blessings of civil and political liberty, letters and arts are introduced, not as a positive convention of any people, but as a natural and unavoidable result.

"It is not merely on industry, but also on the proper appli-

cation of industry, according to the natural situation and productions of a country, that its prosperity appears. Of all employments, the cultivation of the earth, as it is the most indispensable, is the most natural to man; and an attachment to the country seems interwoven in our very constitution. The pursuits of agriculture tend, not only to promote that competency which is requisite to our individual support, but, at the same time, to inspire those dispositions and feelings which are the source of intellectual enjoyment, and result in the productions of literature and taste. Instances might be adduced, both in the ancient and modern times, where the prosperity, and even refinement of a nation, has been chiefly raised upon the basis of successful agricultural pursuits.

"The effect of manufactures is different, and, upon the whole, not so conducive as agriculture, to the formation of intellectual character. It tends to increase the wealth of a country; but, it is much to be feared, that the unavoidable tendency of these employments is, to contract or deaden the exertion of the intellect, and reduce the powers of the body and mind to a machine.

"Of the connection that has, from the earliest ages, subsisted between commerce and intellectual improvement, the records of the human race bear constant evidence. The perfection and happiness of our nature arise, in a great degree, from the exercise of our relative and social feelings, and the wider these are extended, the more excellent and accomplished will be the character that will be formed; and we find, that in every nation where commerce has been cultivated upon great and enlightened principles, a considerable proficiency has been made in liberal studies and pursuits. It is not possible for us to repress our exultation at the rising prospects and rapid improvement of our own country, or to close our eyes to the decisive evidence which every day brings before us, of the mutual advantages which commerce and literature derive from each other. Not only in the metropolis, but even in the commercial towns of the United Kingdom, academical institutions are formed, and literary societies established, upon different plans and different resources, but all of them cal-

culated to promote the great object of intellectual improvement.

"It is not, by the mere laborious and serious occupation only, to which we have before adverted, that a nation is raised to honour and prosperity. Strange and novel as the assertion may appear, it is no less true, that the advantges and enjoyments which these studies and pursuits afford, are not only obtained without any expense to the country in which they are encouraged, but that they actually repay, in wealth and emolument, much more than they require for their support. To what are all the astonishing improvements lately made in manufactures, in mechanics, and in chemistry, to be attributed, but to the incessant researches of those distinguished individuals, whose talents have been exerted to improve the products of the soil, and to abridge the necessity of human labour?

"It would, however, be as degrading to ourselves, as unjust to the dignity of science, to estimate her importance only in a direct and pecuniary point of view. Are the powers of the mind to be considered merely as subservient to the accommodation of our physical wants, or the gratification of our selfish passions? Whatever is wise, beneficient, or useful in government, in jurisprudence, in political economy, is the result of her indefatigable exertions: exertions which always increase with the magnitude of the object to be attained.

"Nor are the arts, connected with design, as painting, sculpture, and architecture, to be considered as drawbacks on the augmentation of national wealth, or as useless dependants on the bounty of a country. How shall we estimate the influx of wealth into the cities of Italy in the sixteenth century, or into Holland and the Low Countries in the seventeenth, as a compensation for those works of art, which continue to increase in value to the present day, and form, at this time, no inconsiderable portion of the permanent riches of Europe? It must be clearly understood, that it is not as a matter of pleasure or gratification merely, or as an object of luxury, that I thus venture to recommend the cultivation of the fine arts,—

my purpose is, to demonstrate their utility. Whoever has attended, in the slightest degree, to this subject, must acknowledge how intimately the improvement in our manufactories have kept pace with the proficiency made in the arts of design; and that these are departments in which these arts, by their sole energies, have greatly contributed to the wealth and reputation of the country.

"I shall, perhaps, be accused of treating the subject in a manner unworthy of myself, and of my audience, by thus seizing upon the arts, whose province is to delight the imagination, and elevate the mind, by chaining them down to labour, in the dull round of pecuniary profit; but if you will protect the arts, the arts will, and ought to remunerate you. To suppose they are to be encouraged upon some abstract and disinterested plan, from which all idea of utility shall be excluded, is to suppose that a building can be erected without a foundation. There is not a greater error than to think the arts can subsist upon the generosity of the public: they are willing to pay for whatever is devoted to their advantage, but they will not become slaves. If, in the infancy of their progress, some assistance should be requisite, such a necessity cannot long exist. The arts can only flourish where they command. Till an artist can produce a work of such merit, as to induce some individuals to prefer it to its value in money, he ought not to expect a reward; it is a bounty and a degradation, and, in its effect, tends to mislead, and not to encourage the art.

"I acknowledge I should be unjust to my subject, were I to rest its pretensions here; and I hope I may be permitted, in a general way, to state the utility and importance of these pursuits. To what mode of expression did the ancients resort, when they wished to perpetuate the achievements of their heroes, or the ideal forms of their divinities, but to sculpture? Nor has this confidence in the immortality of art diminished in our own times. For the heroic deeds, by which so many of our countrymen have, of late years, been distinguished, what has been a higher recompense, or what has marked in a

more effectual manner the applause and admiration of a grateful people, than those splendid memorials of sculpture which have been devoted to their memory."

Mr. Roscoe then proceeds to make some remarks on the studies of literature, as distinguished from the arts and sciences; but as some of his observations apply, with the same force, equally to the three branches of knowledge, when cultivated as the objects of education, refinement, or amusement, we cannot forbear to insert them.

"The delight and instruction which the studies of literature communicate, the perpetual charm which they throw over our hours of leisure, the resources which they afford against indolence and languor, and the strong barrier which they form against vicious and degrading pursuits, will be universally acknowledged; but in what manner they contribute to the prosperity of the community, will not be as easily perceived. But even their direct influence is not inconsiderable. It is scarcely necessary to recur to former times, and other countries, for proofs of the importance of this art in a pecuniary and commercial point of view. Such has been the progress of knowledge and taste in this country, that in order to supply the avidity of the public, immense establishments and manufactories are required, and the commerce of the country greatly promoted.

"Other branches of study have their peculiar objects of enquiry; but those of literature are unlimited and universal, and may be considered as the support, the nurse, and guardian of the rest. Whether the discoveries of science are to be explained and recorded, whether the principles of the fine arts are to be illustrated, whether the rules and institutions of society itself are to be demonstrated and defined, it is she who is entrusted with this important office.

"In thus attempting (continues Mr. Roscoe) to vindicate the studies of literature, and the cultivation of the fine arts, and chiefly on the principle of utility, I am not insensible that I may be supposed to be indifferent or adverse to the opinions of those who have defended them on other grounds. There are many persons who contend their object is to please, and

who attribute the enjoyment we derive from the bounty of the Creator, who, throughout the whole of his works, has shown, that an attention to order, to elegance, and to beauty, corresponding to certain fixed principles in our constitution, forms a part of his great and beneficent plan; but I conceive, in this instance, there is no necessity for our separating the ideas of utility and of pleasure, and of relying for our justification on one of them only. The gifts of the Creator are full-handed; nor has he always placed it in our power to accept of that which is indispensibly necessary, without, at the same time, compelling us to accept of the pleasure that accompanies it.

"With regard to taste and science, as well as in other respects, mankind are the architects of their own fortunes. Experience demonstrates, that it is to the influence of moral causes, to those dispositions and arrangements in the affairs of mankind, that are peculiarly within our own power, that we are to seek for the reasons of the progress and decline of the liberal studies. It is to the establishment of national liberty, to the continuance of public tranquillity, to successful industry and national prosperity, and the wish to pay honour to genius and talent, that we are certainly to refer the improvements that take place."

We have to apologize to Mr. Roscoe, and our readers, for having mutilated this Discourse. The limits of our Journal compelled us to commit this injustice; but we were anxious to avail ourselves of his authority to sanction the principles, upon which we generally concur, that literature, the sciences, and the arts, must depend for their advancement; and, we feel confident, disfigured as they are by us, they will still amply contribute to serve the purpose for which we intend them.

It is usual, in considering literature, the sciences, and the arts, to treat each of these general terms, as comprehending within its meaning, exclusively of the rest, some defined objects of our knowledge or research: but, in attempting to arrange the various branches of human information under such separate heads, we shall find that art is frequently a science,

and that literature sometimes comprizes an art. To make this distinction is of little importance, when it refers to their improvement or progress, which must, in all of them, depend on the same general principles of encouragement, and be impeded by the same obstructions; but when, as we have often found, literature, the arts, and the sciences, are contending, amongst themselves, under these general descriptions, for a priority of merit, in contributing to the happiness of individuals and the prosperity of states, it would be necessary to settle with some accuracy the several departments of knowledge that each includes, before the question can be decided.

We do not, however, feel it essential to our present views, to enter on this criticism. We admit the importance of all; but think that each subordinate branch, without any reference to the general term under which it may be distributed, is best disposed in the scale of excellence by its obvious and immediate consequences, as well as by its real power, in conferring benefits on mankind. Such as operate only, indirectly, or remotely, are subject to such interruption in their effects from the fluctuation of human affairs, and to such discussion as to their tendency, that it appears more suitable to the range of our intellects to decide their comparative value, by means the least liable to dispute.

Painting, sculpture, and music, are arts whose effects frequently and impressively attract our attention; they are the objects of request of the rich and the refined; of persons who command the taste and influence the opinions of a nation, and for these reasons appear to have obtained formerly a greater preference of protection than to us they appear to merit. Although of the two former, the one has the advantage of being connected with drawing and the other with architecture, we can yet conceive that social order might have made great strides towards perfection, without a profound acquaintance with their principles, or much dexterity in their practice: they are more to be regarded as the offspring of established security, as fostered by opulence, and as ministering to our amusements, than as composing part of the cement and materials to which the edifice of society is indebted for its solidity or comfort. Poetry

is in our estimation entitled to the same rank, and were it not for the transcendent merit of the Iliad, written at a period when society must have been imperfectly constituted, would appear, in its improved state, to exhibit at all times the indications of wealth and refinement in pursuit of pleasure; that it has flourished without this protection, may in some measure be accounted for from its independence of other arts and sciences. Poetry is in general a representation of the scenes of nature, of the effects of the conflicting passions of makind, and of the various events which must at all times agitate and convulse our species; it selects or combines the most prominent beauties of the creation, or paints the images that most interest our sympathies and feelings; but as these objects are, either by observation or tradition, always present to our senses, it requires little more than that nature should furnish the genius endowed with powers to collect and describe them in the most impressive form. No other art is equally exempt from the restraints imposed by the ignorance of individuals and the barbarity of governments, or requires less assistance from the sciences to afford distinction.

If it were true that painting, sculpture, and poetry were of the importance sometimes ascribed to them, their effects on the welfare of mankind, might be expected to increase in proportion as they advanced towards perfection. Mr. Roscoe thinks they have not reached the utmost verge of excellence, that we have still much to hope and attain. To determine however this point, we must have some standard admitted to be just, some uncontroverted principles or axioms with which we can compare, or by which we can measure our progress. Taste is too indefinite for the purpose, it is claimed equally by persons who hold the most discordant opinions on the point, whose repugnant pretensions are maintained by the most opposite examples; it is incapable of being transmitted by very accurate rules or description, and in practice frequently appears a term convertible with that of fancy. A writer,* eminent for his genius and critical abilities, has said of the poetry of Pope, " that new sentiments or new images others

* Johnson—Lives of the Poets.

may produce, but to attempt any further improvements on versification would be dangerous. Art and diligence have done their best, and what shall be added will be the effort of tedious toil." Within a few years after this decree was pronounced, the authors of a Review,* whose merit in general cannot be too highly estimated, contended that the modern style of poetry was to be preferred, and that the celebrity of those whose claims to eminence seemed built on the most secure foundations, was already on the decline. We hope we shall not be misunderstood. We do not mean to say that there is not an immense interval between the compositions of Rafael and Correggio and a head on a sign-post, between the versification of Pope and that of Sternhold and Hopkins, the music of Mozart and the tune of a bagpipe, between the rudiments of an art and its matured state, that must strike the most uninformed observer—but inasmuch as this supposed increasing excellence is not attended with, a definite or immediate corresponding advantage to the interests of mankind, we lose one unerring test by which its progressive improvement may be tried. It is sufficient to have been but little conversant with the professors of these arts, to find that their principles of taste become wavering and unstable at the touch of examination; and that they owe some part of their merit to the magical illusions with which genius is generally able to dazzle our understandings.

But far different is the case with chemistry, astronomy, mechanics, or mathematics. In them scarce any discovery is made, scarce any improvement is suggested, but it becomes converted to the use of mankind. As chemistry reduces substances to their elements or combines them in new modes, they assist in medicine, in manufactures, and in all the operations by which the calamities incident to our nature are alleviated or subdued. Astronomy assists to facilitate navigation, and open new roads to commerce. They leave no room to conjecture as to their merits, or any hesitation as to their

* Edinburgh Review, Sept. 1816.

advance. The navigator, manufacturer, statesman, and philosopher concur in their opinions of their progress and effect, and our ameliorated condition affords the best testimony of their improvement. We should sincerely lament to fall under the imputation that we are insensible to the merit of the arts to which we first alluded. They have been found worthy of the pursuit of men of the most exalted talents, they are the admiration of the most refined, and states have founded a portion of their glory on their encouragement and protection. Were we disposed to abate considerably the estimation in which they are held, such attestation of their value would decide against us; but it is more our desire to claim impartial countenance and support for the less splendid branches of our knowledge, whose services are of as much importance, but less obtruded on our observation.

Whatever, however, may be determined as to the comparative importance of the results which flow from these different branches of our knowledge, it is plain they require the same general circumstances to favour their growth; exemption from the desolation of wars, pestilence, and famine, opulence is required to give reward, and leisure must be had for application; but above all, a government should exist in which the preponderating influence of the people forbids that a nation should be subject to the narrow views and interests, that with few exceptions, appear at all periods to have regulated the dominion of despotism. The suspicion natural to tyranny, its dread that light or information should expose its deformity, or the tottering foundations on which it must ever stand, makes it feelingly alive to the dangers resulting to its existence from all freedom of enquiry. If any science could have been exempted from its persecution, that which comprises an explanation of the mechanism of the universe, might have been selected as least obnoxious to its fears: but can we read without abhorrence, the recantation that Galileo was compelled to make of his errors in the adoption of the theory of Copernicus, as being inconsistent with the text of the holy scriptures; or peruse without disgust the remarks which with real or

affected simplicity his biographer* and disciple has made on this signal instance of absurdity and baseness exhibited by the Inquisition. This great philosopher, whose skill was on this occasion rivalled by the excellence of his sense, professed to renounce a system which he had proved was founded on the soundest principles, did not choose to suffer martyrdom in defence of a speculation of which he knew the surrender would afford no permanent triumph to his opponents, and consented to thank Providence for the benefit it had bestowed on him in removing his delusions.

It is impossible to consider the unrivalled eminence which the arts attained during the prosperity of some of the Italian republics, without being convinced of the prodigious effects sometimes produced on the energies of the human mind, by an exemption, not merely from the restraint of absolute authority, but even from the languor and tameness often produced by very regular governments, though calculated for the tranquillity and comfort of a people. The internal condition of these states was a perpetual struggle of faction amongst the citizens, a contest for power and popularity amongst the rich, a defective administration of the laws, and a doubtful state of private morals. We suspect the same observations may be applied to some of the ancient Greek republics, yet amidst such scenes were reared the most finished monuments of art. We by no means recommend that excellence should be purchased at this expense; it is to be hoped, however, that the mode of combining a high degree of freedom with public integrity, is yet within the reach of political chemistry, and the example of one rising republic on the globe seems favourable to the expectation.

The wars of modern days have less the character of ferocity and devastation than those of former periods. How little have the arts and sciences suffered from the sanguinary conflicts and uninterrupted campaigns of twenty years! The sovereigns of Europe, with a policy worthy of enlightened statesmen, confirmed by their anxiety for the preservation of the distinguished monuments of art, the dignity and importance that has been

* Viviani.

at all times annexed to them by the wisest of mankind. The tone of moderation that prevails in Europe, the recent experience of past calamities, we hope may avert for a long period the ravages of hostility; an increasing humanity and more exalted ideas of moral duty will at least mitigate their evils, and precludes the belief that the barbarity of Roman or Gothic conquest should again infest the world.

Besides these general circumstances, which are indispensable to the prosperity of our knowledge, it has always been the object of governments, which have thought the happiness and interest of their subjects merited their attention, to promote the advancement of literature, science, and art by public institutions, in which the various discoveries could be collected and concentrated, by diffusing them again in lectures or publications, by rewards of honour or profit, and by all the inducements which urge men on to excellence and distinction. We firmly believe these are wise expedients, and if seconded by the assistance and example of individuals, conspicuous from their talents and their eminence, must contribute essentially to the improvement of the sciences, and the application of discoveries to the use of mankind.

It is, however, an observation of Bacon, that "the patrimony of learning is sometimes improved, but seldom augmented:" as this remark is intended to include the sciences, it appears to apply in some of them more to the manner than to the amount of their increase. The great discoveries, the extension of the estate of such sciences, has been effected chiefly at considerable intervals of time, and has been achieved by a few men, and amongst them, by some who broke through all the obstacles presented by ignorance, oppression, and calamity to their progress, and unassisted by advice or example, either dug by their own efforts the treasures of knowledge from the ruins under which they were concealed, or with a sagacity only granted to them amongst the children of men, traced, explained, and demonstrated, the eternal laws which guide the mechanism of the universe, or are impressed on the materials of which it is composed. To the appearance of such individuals, neither institutions, rewards, or the labours of former learning, much contributed;

they stood upon an eminence on which the hand of nature had placed them, and from thence surveyed the regions of science, which to the rest of mankind appeared involved in impenetrable darkness. Amongst these Galileo appears in the first rank; he laboured under the disadvantages of poverty, a defective education, and of a constitution impaired by unremitted attention; he came to maturity at a time when the freedom of the Italian republics was extinguished, and learning had lost much of its authority and protection. Yet in a short period, the efforts of his genius, like a revelation, dispelled the mists engendered in the paganism of science, broke the chains of scholastic authority which from age to age had bound the understandings of mankind, and laid the foundations of the most sublime knowledge that a man could leave to posterity as an inheritance.

The merit of Bacon, who was the cotemporary of Galileo, makes a portion of the glory of the country in which he was born. The period in which he lived, and the government of which he was a subject, were not favourable to the pursuits of real science; yet, in the midst of poverty and disgrace, he contrived to leave memorials of acuteness, depth of thought, and extent of views, that stand unrivalled amongst the productions of human genius.

Newton appeared about a century afterwards, and at a period indeed in which learning met the amplest protection, and enjoyed the unlimited freedom it deserves. Sill were his discoveries the early produce of a mind neither excited by the hopes of reward, or by competition, or aided by peculiar instruction. Original and unbounded invention was the characteristic of his genius, and its efforts were animated by the love of truth alone.

The known attachment we have to the distinguished Institution not long since founded, must prevent these observations from being considered as intended to depreciate its value; but it is always of advantage to such establishments, that the benefits to be expected from them, should neither be exaggerated or mistated. The public are apt to hope for a rapidity of improvement which experience does not justify us

in concluding, is often the result of the best digested plans, and disappointment frequently leads them to think that because much has not been at once effected, that nothing can be done. Some sciences and arts appear in their mode of advancement, to form exceptions to the laws which direct the progress of the rest, and are best promoted by assembled talent and instruction. The knowledge of chemistry has been obtained by a gradual accumulation of discoveries, by unwearied experiment, and incessant observation. It has been augmented by this slow process of continued addition, and its mass now being subjected to the invigorating warmth of the rays of genius, forms the most extended, rich, and productive possession, that can be cultivated for the use of man.

With all the attention, however, that talent or industry has bestowed on this science, no general principles seem to have been detected, by which, as by the laws of gravitation and motion, a series of discoveries are at once revealed, or numerous phænomena explained. Experiment has not often furnished more than insulated facts. To the preservation of these, to their adaptation to the purposes of society, to their accumulation, to their diffusion as an increase of knowledge, public institutions are eminently calculated. Such assemblies disseminate widely the love of science, they open a ready access to obtain it, they concentrate the expensive *materiel* indispensable to its advancement, and add a splendour to the intrinsic value of human information.

In a government constituted like our own, where although the people have considerable authority, conventional and hereditary distinctions add to the natural predominance of wealth, and effectually secure to those who are possessed of them, a large portion of power, it is of great importance that the persons thus distinguished, should contract a taste for such arts and sciences as are most conducive to the morality and well-being of the people. Their example and opinions are obviously decisive, in regulating and directing the habits and tastes of a nation, and through intermediate steps even to low gradations in the orders of the community. The productions of some of the arts which have always secured the highest

share of protection amongst men eminent by their rank and opulence, and when enjoyed by them in the perfection they sometimes attain, tend to their refinement, and to fix their attention on some principles connected with science, do not, as we believe, in an inferior degree of improvement, when they become the objects of request of the less informed classes of mankind, much conduce to benefit their morals, or to enlighten or strengthen their understandings; but some of more exact sciences, as chemistry and mechanics, in their most elementary principles, and still more in their advanced state, are equally well calculated to fill up their leisure, and must always help in extending, sharpening, and improving the human intellect, and we think by such powerful authority, might be recommended with success, (not to the total exclusion of other sources of amusement, which is neither possible or to be desired;) but to assist in conducing to their happiness. With such encouragements as these, the improvements in the arts and sciences must be preserved, and soon receive assistance by a gradual augmentation of discoveries. No circumstances lead us to suspect, that experiencing the benefits of the increasing comforts they confer upon us, we should blindly and voluntarily abandon the road which led us to this state of happiness and prosperity. It is, however, an observation founded on unquestionable facts, that some arts and sciences have attained at particular periods of the history of mankind, a high degree of excellence and perfection; and that afterwards, without any marked or obvious cause, they have ceased to advance, have gradually declined, and have sometimes been for ever lost. We do not pretend to the learning that can enable us to remove the difficulties that attend a question filled with intricacy and doubt, but still we think some light may be thrown on the subject, by an attention to the distinction we have before attempted to enforce, between such arts and sciences as are matters of taste and amusement, and such as by their effects promote our comfort, and protect or secure our existence. In the desolation of barbarous wars, when whole nations are eradicated or transplanted, and the habitations of men and means

of subsistence are swept away, all learning, sciences, and arts, must necessarily be involved in undistinguished ruin, and were it not that their vestiges have sometimes been impressed on materials, on which human madness had exercised its fury in vain, we might be ignorant they had ever existed: but history affords no example of a nation, that having made considerable progress in sciences and arts serviceable to mankind, and who by experience, had learnt the comforts they added to our existence, ever relinquished without compulsion or necessity their use and their improvement, unless, perhaps, where one art could be better supplied by the adoption of another. The memorials that remain of the ravages of wars throughout the globe, sufficiently account for the disturbance and interruption the progress of such arts have received at all periods since man has been enabled to record his transactions; and although the first principles of sciences cannot be wholly obliterated from the intellect of our species, their improvements, which are always interwoven with a variety of knowledge and dependant on each other for their mutual support, are easily impeded, and when once this embodied system is broken or destroyed, we must again resort to the rudiments of our information. Our longest period of exemption from such calamities, is too short to have ascertained by experience, that we are as capricious in our attachments to the means of comfort and the modes of protecting and securing our existence, as to the effects of those arts which form our amusements, our luxury, or pleasure, or are connected with our prejudices or superstitions. The latter arts must ever be subject to fluctuation in their degrees of perfection, from the alteration of our tastes, our love of variety, the natural instability of our wishes, or the proportion of reason with which we happen to be enlightened; and although a change in our desires, inclinations, and understanding, may be too gradual for distinct observation within a very limited period, it must infallibly operate to abate the ardour of improvement and diminish the incentives to excellence in such arts as are ceasing to be the objects of our request or admiration. Painting, sculpture, poetry, music, magic, and astrology, have been peculiarly subject to these

alternations of real and sometimes imaginary rise and of decline. Many arts known to the ancients, would probably have been lost from these causes, without any violent vicissitudes in the kingdoms of the world. It did not require Egypt should have been successively the prey of the various nations who subdued it, that the art of embalming a man or an Ibis should be forgotten, or that it sometimes should have been progressive and sometimes stationary; and we have no doubt that the philosophers of Memphis had often reason to enquire, at what periods in the annals of Egypt, the professors of the science of corporal eternity had attained the summit of their glory, or were relapsing into ignorance and barbarity.

But when the cruelty of conquest has ceased to extirpate mankind and their habitations, the arts and sciences, which contribute to the well-being of men, invariably improve, or at least rarely revert from an improved state to that of inferior cultivation. Astronomy, mathematics, chemistry, mechanics, navigation, agriculture, manufactures, have all obtained a gradual or sudden augmentation in their excellence and value since their revival after the fall of the Roman empire, and although great difference may exist in their degrees of perfection in different countries, or in the same country at different times, no person will hesitate to pronounce that the patrimony of such learning is continually improving and sometimes increasing.

It is not, indeed, immediately connected with the object of our Journal, but it may not be improper to observe, that these remarks extend to most other sciences useful to man, with the exception of the civil code of law in one distinguished empire, and of christian theology in general. The former in the excepted country has been nominally improved, augmented, and refined; but it is become nearly useless in furnishing principles for the guidance of mankind in their various dealings, and almost every civil transaction requires a decree for its explanation. The latter is not, perhaps, gaining in its purity, though certainly it has much extended its dominion and influence, and we are not sure it can be much

benefitted, except by inspiration. The daily discussions we hear, do not give a favourable opinion of its advance, and we may safely assume, that the highest state of excellence it ever attained, was at the period of the revelation, and in the few successive years in which the apostles had the managment of its doctrines.

The celebrated Rousseau was the author of a treatise abounding with ingenuity and glowing with eloquence, in which he attempts to prove that no advantage has been derived to mankind from the cultivation of the arts and sciences, and that in proportion as we deviate from the simplicity of our habits and our tastes, we are steering our course from the shores of happiness and tranquillity. If it could be proved there had been many sectarists of this philosophy at different periods of the world, we might attribute the various declensions of our learning to the labours of such enlightened individuals; but we do not believe such sect ever existed, or that Rousseau ever made a proselyte, and there are some reasons to suspect he did not convince himself. It is true, that he retired from the society of the learned and the tables of the rich, and assumed the language and manners of a distinguished Cynic except the residence in a tub. But he was never satisfied with the change, he seized the most frivolous pretences for escaping from his retreats, and at last contrived to fix his permanent residence and close his life in the gardens, and contiguous to a palace and the splendour of the house of Luxemburgh.

Whether some of the arts have attained their utmost degree of perfection, or that there are irremoveable boundaries beyond which human science is not permitted to penetrate, we cannot determine from experience. We have no reason to think that it is yet time to relax in the endeavours of extending our enquiries into any branch of knowledge, because we know enough, nor that any of the objects of our researches are like the fruit of the tree that grew in Paradise forbidden to our taste, because we may know too much. With the intimate causes, indeed, of the laws that regulate the phænomena

of the universe, and of its materials, we shall probably never be acquainted; and the doors of such science, for reasons that can be only known to the Author of our being, seem closed before our steps.

It is improbable that learning and science should be enlarged, until their extent will render them unmanageable, and overpower the strength of our understanding. One of their great improvements consists in removing the materials and scaffolding that served only to rear the edifice, and in leaving the columns which support or ornament the temples of our knowledge, free from the rubbish that may impede our access or intercept our views.

Before the appearance of Newton, our ancestors were, perhaps, hopeless of penetrating further than they had done, into the mysteries of nature; and the veil that he removed, and the wonders he disclosed, were not the objects of their expectation. That such a man may again appear, is not impossible, and that the prediction in Seneca may be accomplished often in its figurative, as it has once been in its literal sense, is to be earnestly desired.

> Venient annis sæcula seris
> Quibus oceanus vincla rerum
> Laxet, et ingens pateat Tellus.
> Tethysque novos detegat orbes,
> Nec sit terris ultima Thule.

ART. II. *A Description of Adam's Peak.* By JOHN DAVY, *M.D. F.R.S. In a Letter addressed to Sir Humphry Davy, F.R.S. LL.D.*

Colombo, May 1*st*, 1817.

I AM just returned from Adam's Peak. It is a noble mountain, surrounded by mountains, and surpassing them all. The road to its summit, for eight miles, is steep, difficult, and, in

a few places, dangerous; it passes through fine wood, or impenetrable jungle, over the faces of enormous masses of rock, on the brink of precipices, and through the beds of rivers. In the most difficult places the ascent is facilitated by rude ladders, made of the boughs of trees, by steps cut in the solid rock, and by strong iron-chains. The road, such as it is, is decidedly artificial, made for the use of pilgrims; and is not, as it is commonly reported, the bed of a mountain torrent. Its direction, the loose sand, and gravel, and clay, with which it is covered in many places, are circumstances incompatible with the idea. The area of the top of the mountain is about 72 feet by 54. This spot is sacred: it contains the imaginary impression of the foot of Buddou, is consecrated to devotion, surrounded by a low wall, and skirted by a grove of sacred trees. These trees are said to be a new species of rhododendron; they are of a respectable size. Their foliage, which is ever-green, is dark and thick; and their flowers bright red, large, and magnificent. The natives hold these trees in high veneration, no one ventures to touch a leaf, and much less gather a flower. The tradition is, that they were planted by the God of the Hills when Buddou left the earth, and took his departure from this mountain. If report be correct, they are found in no other part of the island. The imaginary impression of the foot of Buddou is on a rock, nearly in the centre of the inclosed ground: its resemblance to the impression of a human foot is very rude indeed. It is an oblong, five feet four inches long, and two feet seven inches wide in the widest part, which is over the toes. The toes are five in number, and all of the same length. The whole is surrounded by a margin of brass, ornamented with a few bad gems, chiefly rock-crystal, the green jargon, and the ruby, or rock-crystal, with a foil underneath it, to represent this precious stone. It is covered with a small square wooden building, which we found (it being the season of the pilgrimage) decorated, and very gay with flowers, and streamers. The sacred impression of the foot, to which the mountain owes all its interest amongst the natives, is, I have good reason to believe, in a great measure artificial, and the work of priest-

craft. Some religious enthusiast probably first climbed the mountain, and, to give it celebrity, made this impression, and invented a story to suit it. Be that as it may, at present there are evident marks of design about it. I could observe on its surface traces of the labour of the workman: and the partitions which are between the toes, though resembling the native rock exactly in appearance, I found, on examination, to be a composition of lime and sand. The influence of religion on the minds of the natives, is well exemplified in the immense number of pilgrims that annually ascend this steep and rugged mountain. The number must amount to many thousands. We saw, at least, two or three hundred. They were of all ranks and descriptions of people, from the highest to the lowest casts, women as well as men: all ages, from the child that was carried on its father's back, to the gray-headed tottering old man, that could not ascend without support. The object of their worship is a strong example too of the lowness of their faith, and their amazing credulity; it was painful to see them on the summit of a mountain, overlooking some of the sublimest and most beautiful scenery in nature, forgetful of the God of Nature, and prostrate before a thing deserving only of contempt. However, few national rites, or generally received customs, whether religious or civil, that differ from our own, are so bad as they at first appear. This worship of the natives, when examined into, appears, at least, harmless, and is, probably, attended with good effect; it is accompanied by no cruel rites, or bloody sacrifices; the offerings are of the fruits of the land; the prayers of the supplicants are, first for their parents, next for the prosperity of the shrine, and lastly for themselves. Before the pilgrims descend, an affecting scene takes place; they exchange with each other the betel-leaf, their token of peace; wives shew their respect and affection for their husbands, by their profound salams, and children for their parents, and friends for one another. Thus the ties of kindred are strengthened, friendships are confirmed, and animosities removed. They are then blessed by the priest, and bid to return to their homes, and lead a virtuous life.

Geologically considered, the mountain may be said to be composed of gneiss. The rock on the top, on which is the impression of the foot, is gneiss, of a very fine grain. It abounds in quartz. It is hard and compact, of a gray colour, and only in mass exhibits a flakey structure. A little below felspar predominates, and the rock is rich in garnets. Here it is in a soft state; and, towards the surface, rapidly decomposing. Still lower, hornblende prevails, and in so large a proportion, that particular masses may be called hornblende rock. Near the bottom felspar again predominates, and the rock contains much molybdena disseminated through it. Besides, in different places, the rock exhibits other peculiarities: here abounding in quartz, in a massive form; there in mica, in large plates; and very frequently rich in iron cinnamonstone. Garnet, traces of the ruby, and adularia, were the only minerals which I observed; but, I have no doubt, more minute examination would have detected others, and particularly the corundum, all the varieties of which, including the finest blue sapphires, are found in considerable abundance in the alluvial country at the foot of the mountains.

The height of Adam's Peak has not hitherto been accurately ascertained. The assertion of some authors, that it is 15,000 feet, is evidently incorrect. From the barometrical observations I made, I do not believe that its perpendicular height, above the level of the sea, exceeds 6343 feet. I had not the means of measuring it accurately, in consequence of there being no barometer to make the necessary observations below. On the top of the mountain I made two observations: one in the morning, and the other in the evening. In the morning, the barometer remained stationary at 23° 75′, after having been exposed to the air about half an hour, till it had acquired the temperature of the air itself, which was 58°; and, in the evening, similarly exposed, it stood at 23° 7′, the temperature of the air being 52°. The supposition that the height of the mountain does not exceed 6343 feet, is founded on these observations, of which it is the mean result, and on the idea, that the average height of the barometer, at the level of the sea, is about 30 inches; which, from what I have

observed within the tropics, is not, I believe, far from the truth; and that the average temperature of the air is 80°, which it generally is at Colombo, on the sea-shore, at the hours the above observations were made.

I regret we did not remain long enough on the top of the mountain to observe the range of the thermometer, which, I have no doubt, is there very great. We reached the top towards evening, spent the night on the mountain, and proposed continuing there the next day, but our native servants could not be made to stay; for the first time in their life they experienced the sensation of cold, and shivered from its effect; they were so much alarmed at their new and disagreeable feeling, that they resolved to go down at all events,—"they must die," they said, "if they remained there." At three o'clock in the afternoon the thermometer, in the air, was at 54°, just after a heavy thunder-storm, attended with much rain; at four o'clock it was 52°; at six, 51°; at nine, the same; and, at seven o'clock the next morning, just before we descended, it was 59°. During the whole time, the direction of the wind was from N. and by E. to N. N. E. The sensation of cold we experienced on the summit, was much greater than we expected from the state of the thermometer, owing, probably, to the rarity of the air producing an increased evaporation from the surface of our bodies; not to mention other circumstances which also must have co-operated, as the sudden transition, as it were, from a temperature of 80° to one of 51°; a brisk wind, which blew when we were on the top; and the fatigued and nearly exhausted state in which we found ourselves when we arrived.

The country, between the foot of Adam's Peak and Colombo, is interesting to the traveller; it exhibits fine mountain scenery, that brought to my recollection some of the most beautiful parts of the highlands of Scotland; and here and there the vallies presented rich meadows, that, in appearance, rivalled the verdure of England. The country however, in general, is overgrown with wood and thick jungle; and, in consequence, the low grounds are extremely monotonous. The only rock that makes its appearance, from the Peak to

Colombo, is gneiss, varying, in the proportion of its constituent parts, in different places. It is curious to observe this uniformity of rock, for the space of sixty miles. The soil too, in general, as well as the rock from which it is derived, is every where pretty similar; it is, most commonly a fine light loam, composed of silicious sand, and clay, and iron, in variable proportions, with about one or two per cent. of vegetable matter. The soil is so favourable to vegetation, and the heat and moisture so conducive to the same end, that every spot where a root can fix itself is covered with foliage. Nothing is wanting but industry, enterprise, agricultural knowledge, and, above all, the complete abolition of the old feudal system of government, to convert this wild and beautiful country into a garden, when it will really merit the name of Paradise, that from time immemorial it has acquired, though ill deserved.

I am, &c. &c.

J. DAVY.

ART. III. *Report of the Select Committee of the House of Commons on Petitions relating to Machinery for manufacturing of Flax, dated May* 23, 1817; *referred to in our last Number, page* 341.

The Committee to whom the Petition of Samuel Hill and William Bundy, and also the Petition of James Lee, were referred; to report the same, with their observations thereupon, to the House; have examined several Witnesses in support of the allegations of the said Petitions, and agreed upon the following Report:—

YOUR Committee, in obedience to the directions of the House, proceeded to take into consideration the petition of Messrs. Hill and Bundy, on their improved method of preparing flax and hemp in a dry state, from the stem, without undergoing the former process of water-steeping, or dew-retting.

Your Committee received satisfactory proof, that the preparing flax and hemp, in a dry state, for spinning, answered most completely, and was likely to prove a great and valuable improvement both to the grower and manufacturer: the cost of preparing being less, avoiding the risk of steeping, which is considerable, a great saving also in time and material.

It was proved also to your Committee, that the strength and quality of cloth, manufactured from flax thus prepared, are much superior to that produced from flax which has been water-steeped or dew-retted.

Your Committee are fully impressed with the great national advantages likely to result from this discovery; by which it would appear that a saving, in the proportion of ninety to thirty-three, would be obtained on the annual growth of flax in the empire, computed at 120,000 acres; affording an increase of employment to many thousands, and an augmentation of the national wealth to the amount of many millions, as will more fully appear by reference to the evidence, in corroboration of the allegations set forth by the said petitioners.

It appeared also in evidence before your Committee, that the flax prepared by Messrs. Hill and Bundy's machines was superior to any dew-retted flax; and that large orders had already been given for flax thus prepared, by the house of Messrs. Benyon and Co. at Leeds, one of the most considerable manufacturers of flax in the kingdom.

Your Committee proceeded also to the consideration of the petition of James Lee, but did not feel themselves competent to go into any examination of the allegations, stating an infringement of Mr. Lee's patent. As far as the evidence before the Committee was adduced, it did not seem to justify such an assumption. This, however, is a question for a court of law.

Evidence, on the part of Mr. Lee, was produced to your Committee, to shew Mr. Lee's machines were in use in various workhouses, in different parts of the kingdom; that Mr. Lee's manner of preparing flax was without water-steeping

or dew-retting, and affords additional proof of the great advantages of the practice.

Your Committee must also call the attention of the House to the essential benefit that will be derived to the cultivators of flax, from the quantity of valuable food for cattle obtained from the new method of preparing flax.

It has been given in proof, that the boon, or outer coat of flax, contains one-sixth of the gluten of oats.

Mr. John Millington's Evidence.

What are you?—I am a civil engineer, and professor of mechanics at the Royal Institution.

Have you seen Messrs. Hill and Bundy's machines at work, preparing flax and hemp for the spinner?—I have.

What is your opinion of the effects produced by the breakers in the first process?—They seem to answer the purpose of taking off the boon, or woody part, from the flax. I observed that this was pretty effectually done by once passing through the machine, which consists of five rollers. I accurately weighed (first adjusting the scales, and seeing that they were correct), one avoirdupois pound of the stem, or flax, in its dry state, as it comes from the farm. It required five minutes to pass this through the machine; but I took care not to let the man know I was timing him, lest he should make an extraordinary exertion; and he seemed to be working at the ordinary rate, at which he could continue to work for a length of time. I found, upon weighing the product when it came from the machine, there was a loss of nine ounces and three-eighths; consequently, six ounces and five-eighths of useable materials were obtained, that is, of fibre or harl, as it is called generally. It was then passed through the second machine, called the rubber, or rubbing-machine. This required eight minutes for the quantity which was left. The result of this rubbing was, four ounces and a quarter of harl, or fibre, in a clean state, fit for the hackle. Some gentlemen present observed, that it was scarcely clean enough, and it was passed through a second time. We divided the quantity into two

equal parts, and the second process took three minutes; but, if the whole quantity had been used, I do not think it would have required more exertion. The whole process for the pound took sixteen minutes; and the loss, upon weighing it after the process, was exactly three-fourths, without a fraction; so that there was one-fourth of very good and soft fibre produced, fit for the hackle.

How far are you of opinion, that the hackling-machine* completes the material for the spinner?—I have seen the process of hackling by the hand; and I have likewise seen the model of hackling machinery, invented and made by Fenton, Murray, and Wood, of Leeds; which, by certificates sent to the Society of Arts, appears to be the best machine that had ever been constructed, up to that time. I certainly conceive this to be still better, and an improvement upon theirs; but, at the same time, I think the machine, as it now stands, would admit of further improvement, as to velocity. It appears to me to do its work very well; but I have my doubts whether, in its present state, it will do that work with sufficient rapidity.

What quantity do you suppose a man will be capable of breaking and rubbing by the first machines in a day?—That will be answered by a prior calculation which I made, when there were one man and a boy at work; but, at the same time, I ought to state, I tried the power, and it was nothing like the power of a man. One man might, with facility, turn several such machines, though each would require a child to attend for the purpose of feeding, and taking out the product.

What is your opinion as to the machines being liable to be easily put out of order?—I do not conceive they are subject to get out of order. The rubbing-machine will, no doubt, be subject to considerable wear in the rubbers; but those merely consist of small pieces of beech-wood, which may be replaced at any time, by any carpenter in the neighbourhood, where the machine may be, without applying to the patentees.

In case of any accident to the machine, could it be easily repaired by a common blacksmith?—With the exception of

* This machine is not among those described in our last Number.

the breakers, I do not think they are likely to get out of order.

Is not turning three machines too much for a man?—I do not conceive it is at all.

Children may supply the rest of the work?—Certainly: without doubt.

Have you made any experiments as to the nutritive quality of the chaff?—I have not myself made the experiment, but I requested Mr. Brande, who is professor of chemistry at the Royal Institution, to make such experiment, and I have myself seen the analysis going forward. The result was obtained only this morning, and it appeared to be one-eighth of actual nutritious matter, from the quantity experimented upon. Another quantity, which appeared to have been materially injured by the weather, but which must be explained by some other witness, for I do not know how it came so, yielded one-twelfth of nutritious matter; that appeared to me as of the worst quality, and as if it had been subject to wet weather, and had a portion of its nutritive matter washed from it.

Would not that, which had gone to seed, have less nutritious matter, than that taken before seeding?—Yes.

Do you know the quantity of nutritious matter in straw and hay?—I have not had an opportunity of trying it.

Is there any oil in it?—We have not had an opportunity of examining it, but I expect there is. The general idea of oats is, that there is about one-fourth part of waste, taking it altogether; that the oat itself contains three-quarters of nutritious matter, and one-quarter in the shell and waste. It is probable, therefore, that this chaff must be a nutritious food. If this is the case, the nutrition would be about six to one: that it would require six pounds of this, to render nourishment to a horse, equal to one pound of oats. Mr. Sewell, of the Hounslow flax-mills, informed me, that he had been in the habit of offering flax-chaff to his horses, and that, when they were accustomed to it, they would leave clover-chaff to come to this food.

Are you of opinion that Messrs. Hill and Bundy's machine may be of use to farmers and cottagers at their own homes?

—I should conceive, in answer to that, that the machine would be too powerful and expensive for small farmers, but that they would be highly beneficial, if they were introduced in districts; for instance, in a workhouse, or any parish establishment, where eight or ten such small farmers might have access to them.

Have you seen the calculations made by Mr. Hill, respecting the number of people that might be employed, if those machines were general?—I have seen those calculations.

What is your opinion of them?—I believe they are correct, with the exception of one circumstance.

The quantity taken in his pamphlet* is rather under what I make it myself. On a supposition that there are 120,000 acres of flax and hemp annually grown in Great Britain and Ireland, and that, on an average, three tons of stem are produced, from each acre, this will be . . 360,000 tons.

By the operation of Messrs. Hill and Bundy's machines, one-quarter of the above quantity is obtained in fibre, or	90,000 tons.
But, by the old process of dew-retting, only one-eleventh part of the above 360,000 tons is procured, or	32,727 tons.
Giving an excess of fibre saved by the new process, from the same number of acres, amounting to	57,273 tons.
	×20 cwts.
	1,145,460
	×112 lbs.
	2,290,920
	1,145,460
	1,145,460
This number of tons, when produced in pounds, gives of fibre or flax, hemp, and tow,	128,291,520 lbs.

Now as, on an average, it will require half a pound of flax to the yard of linen cloth, this number of pounds would an-

* A plan for redeeming the poor's rate, &c. by Samuel Hill, Esq. Harding, 1817.

nually make 256,583,040 yards of linen cloth, from the additional quantity of flax, hemp, and tow, procured from the same number of acres grown. This quantity of linen cloth, selling in the shops on an average of 2*s*. per yard, would give an annual increase to our national wealth, from the same number of acres employed in this cultivation, of £25,658,304. Exclusive of the cost of the raw material, and the expenses of preparing it by Messrs. Hill and Bundy's machines; the expense for spinning and weaving it into linen goods is taken at £52. 17*s*. 8*d*. per ton. This cost of labour, on the quantity of flax, hemp, and tow, saved by the operation of these machines, namely, 57,273 tons from the 120,000 acres, would amount to £12,114,747. 2*s*. and which would yearly give employment to 807,649 persons, calculating the value of the labour of each at 1*s*. per day the year round, and estimating them to work 300 days in each year. This average will not be considered too low, when it is considered that a large portion of the labour is performed by women and children.

Are you acquainted with Mr. Lee's machine, intended to effect a like purpose with those of Messrs. Hill and Bundy?—Not particularly: I saw a machine, or set of machines, which I was informed were Mr. Lee's, at St. Pancras workhouse, about three, four, or five months ago; those consisted of a scraping-machine, lying horizontally; the flax was held by one hand, and drawn through this machine, while the presser, having teeth in it, was worked by the other hand. There was also a swinging-machine. I do not know the names by which he designates his particular machines, but it appeared to be precisely the same as the machine which is now in this room. I enquired particularly at that workhouse whether that was the whole process, and was informed it was all they knew of; but Mr. Lee has this day shewn and explained his machinery to me. I find the same two machines which I before saw, namely, the horizontal and vertical machine; and, in addition to that, a machine, consisting of fluted rollers, which I had not before seen. I have likewise, this day, seen some flax passed through the several machines, with the exception of the horizonta machine. I did not see that used; but the woody matter ap-

peared to be very well separated by the swinging machine. It was afterwards cleared by passing the fluted rollers, in a skain, formed by passing one end into the other, so as to make a perpetual revolution; and this seemed to me to answer the purpose as effectually as the machine of Messrs. Hill and Bundy: it produced the same end, though by a different process. I am not, however, prepared to state the difference in them, though I have no doubt the loss or gain would be precisely the same. Mr. Lee then passed a portion of flax-stem through the fluted rollers, without the operation of the beating-machine; and this, I must confess, did not appear to me to answer the purpose of separating the woody part from the fibres: it was merely broken into short pieces, but it did not peel off, or leave the fibre.

Do the machines of Messrs. Hill and Bundy resemble those of Mr. Lee?—I do not myself, speaking candidly, see any similarity. The operation of Hill and Bundy's first machine is different from a regular revolution by rollers, inasmuch as an alternating motion is produced, and there is such a distance between the teeth in their machine, that the woody matter has an opportunity of escaping; while, on passing through the rollers of Mr. Lee's machine, it appears to me to be compressed upon the fibre, instead of separated from it.

Have there ever been any machines in use prior to Mr. Lee's, for the purpose of dressing flax in this manner?—I am not certain that flax has been dressed by the dry process; but the old machine, which has been in use for a great length of time, approximates very closely to both the beating-machines of Mr. Lee. The swinging-machine is exactly similar to a machine of Mr. Bond's, deposited in the repository of the Society of Arts; except that his works in a nearly horizontal direction, while that of Mr. Lee's works in a vertical one. I have never, till lately, paid much attention to the operation of dressing flax; but having had occasion to notice that subject in my Lectures at the Royal Institution, I have investigated the different processes, as far as I was able to obtain information, from books and inquiry; and it does not appear to me that the process of breaking by tooth-rollers, moving

with a regular continued motion, is new, inasmuch as that is described in an old edition of Chambers's Cyclopedia.

Do you conceive those two machines to be likely to produce great national advantage?—I certainly think, that as far as employment of the poor can produce them, they do hold out very reasonable and fair ground for supposing, that a novel branch, or rather an extended branch of manufacture, may be introduced into this country, by the improved process of manufacturing flax. There is a great prejudice existing in the country, among farmers, from the circumstance of flax making no return to the land. It is unlike other crops, inasmuch as it is pulled up by the root, instead of being cut; and, by the old process, all that was nutritious in it was wasted, or washed away, by the process of water-steeping; whereas, from the analysis which has just been mentioned, it appears that if the product should be wanted for food, that flax is as capable of making a return to the land as any other crop. Another material advantage in the present process is, that instead of the flax becoming ripe at nearly the time of corn-harvest, and requiring to be attended to immediately, it may now be dried in the same manner as hay, and laid up in barns, so as to afford winter employment to farmers' servants, and others, at a season of the year when such employment very rarely exists in any other form. It would, therefore, enable the farmer to keep a greater number of servants, with advantage to himself, and to the other parts of his farm, than he could afford to do, if he did not encourage this kind of culture.

Would it be highly beneficial also in wet weather?—Yes; it would afford means of employmont in wet weather.

Have you any mode of calculating the expense of the old process, compared with what it would be by the improved system?—I have not.

You said it would require sixteen minutes to pass through both machines separately; would not both machines work at the same time?—Certainly; but it would require preparation to connect the two processes. There is no doubt but that the two machines might be working at the same time; though, as this was an experiment upon a particular

quantity, one machine was standing idle while the other was in use.

Then a pound might be done in eight minutes?—A pound would be done in eight minutes, and part of another pound begun; because part would have passed a second machine, and there would have been a lapse of three minutes upon the second machine.

What you speak of, is a pound of rough material?—A pound of flax in its dry state, as it comes immediately from the farm.

How many pounds of flax could be prepared in twelve hours, and by what number of hands, by the machine?—Twenty pounds by one man and two children.

Would that machine require the full power of a man, or could he work more machines than one?—He could work one breaking, and two rubbing machines, with three children.

Then the three machines would require how many hands?—One man, and three children.

They would do sixty pounds?—No: forty pounds; twenty pounds the breaking-machine, and twenty the pair of rubbing-machines.

Would a man be able to continue twelve hours driving that machine?—Not twelve hours, because twelve hours has always the interval of dinner, and so on; ten working hours is usually a day's work.

Could he work that?—I have no doubt he could: I have known men work ten hours at more laborious work than this.

Have you seen the hackling-machine employed?—I have: and I have stated, respecting it, that it went too slowly.

Do you know the quantity it would dress in two hours?—No, I do not.

Do you know the waste?—The waste on what I saw was very little: I merely saw one handful passed through it, and the waste was not a fortieth, I should think, but it was not weighed.

A very trifling waste?—Yes. I do not, however, myself conceive the machine to be in its perfect state.

Is Mr. Lee's, or Messrs. Hill and Bundy's, the most simple?—Certainly Mr. Lee's is the most simple.

Do you apprehend that Mr. Lee's, being the most simple, is less liable to be put out of order?—Certainly it is.

That part of Messrs. Hill and Bundy's, that is more liable to be put out of order, consists of beech-wood.

Could that be put in order again by any common carpenter? —The rubbing part might; but the machines contain wheels, and some degree of intricacy, in their other parts.

With regard to the rollers, they are not liable to be broke? —I conceive not; the only parts which would be subject to wear, would be the pivots on which they turn, and they could be replaced very easily.

Mr. Lee's machine, you said, had not the effect of separating the woody part from the fibres?—The beating process separated it most effectually, but not the rollers; but I ought, in justice, to say, that Mr. Lee told me that this arose from the flax not being sufficiently dry; and I then had Mr. Lee's assurance that it would answer, if dry.

Do you suppose the small rolling-machine of Mr. Lee's would complete the business well, if the flax had been good, or formed into a skain?—I should doubt it very much, without the application of the breaking-machine.

Will not the rollers, in Mr. Lee's patent, tend to divide the fibres, and render the flax finer, when it is brought to the hackle?—Certainly: any pressure upon the stalk of the flax, so regulated as not to cut the fibre, will tend to spread or open it, and make it finer; but that is equally well answered in the rubbing process, for there it is spread; and, in the other machine, a simple roller, without fluting, would answer that purpose.

The other witnesses examined on this subject were Mr. James Mead, foreman to Messrs. Benyon of Leeds, above referred to; Mr. Ralph Wood, bailiff at Stoneley Abbey, Warwickshire; James Prentice, foreman to Messrs. Hill and Bundy; Lieut. Wright, R. N.; John Millworth, a labourer; Mr. Samuel Hill; Mr. James Lee, the proprietor of the respective machines above alluded to; and Elizabeth Wilson, and Sarah Smith, who had worked at the machines. But as the evidence of these parties was generally corrobative of Mr.

Millington's, which we have given at full length, and went to explain practical details, we have merely selected such parts of it as appear of greatest interest with the public.

Mr. Mead stated his own practical experience, that the new dry process was greatly superior to the old one of dew-retting, which frequently injured the fibre. That the expense of breaking and dressing flax by the old process was from 20*l.* to 25*l.* per ton. That Hill and Bundy's machine does not injure the fibre, nor is it so complicated as to be liable to be out of order. That the opinion of the Yorkshire farmers is, that flax does not injure the ground as a crop, but is objectionable, on account of its producing no manure. That he had seen Mr. Lee's machines worked at St. Pancras workhouse; that the average quantity done there by a man in a day, as appeared by their books, was $2\frac{1}{2}$ lbs.* and that the waste on these machines appeared much greater than on those of Hill and Bundy.

Mr. Wood stated that he was acquainted with the cultivation and dew-retting preparation of flax. That the average quantity of stem produced on an acre of land, was from $2\frac{1}{4}$ to 3 tons. That the proportion of fibre expected to be obtained from dew-retted flax, was about one in ten or eleven. That dew-retting affects the fibre; and that a considerable loss of flax is attendant upon removing it from the field to the pit where it is steeped, and again in spreading it, and taking it back. That the length of time flax must be steeped, depends upon the weather; and that the process of steeping, is one which requires a great deal of judgment. That flax was not at all an impoverishing crop, that it may be grown upon any land, but that loamy black land was the best for it; that it suits ground which is first broken up; that it is generally followed by a bare fallow, or turnips, and is a good preparation for wheat; and generally, that Hill and Bundy's machines will separate the wood from the fibre, and work the flax at a cheaper rate, and in a better manner, than any other machine he has seen.

* This is what Mr. Mead stated, and is correct; but in the printed report of the Committee, the quantity is stated at ten pounds and an half.

Mr. Prentice stated, that he always found the produce from Hill and Bundy's machines, to be one fourth of the weight of the stem used, and that this fourth was in a fine state, ready for the hackle; that he had hackled it, and it produced two thirds flax and one third tow; that one man could turn two breaking machines, two rubbing machines, and one hackling machine; and this would require five boys, viz. two to feed and attend each breaking machine, and one to attend the two rubbers and hackle; that each breaking machine would produce from 80 to 100 lbs. of prepared flax in a day, and each rubbing machine would do half an hundred weight in the same time; so that two rubbers would be necessary to each breaker; that the expence of labour, exclusive of machinery, was something under 5*s*. per cwt.; that he had done from 9 to 10 lbs. in an hour, when the machine worked by power, but that 7 lbs. per hour he supposed might be done by a man; that he had not found the machines liable to get out of repair.

Lieut. Wright corroborated the testimony of Mr. Millington as before stated, he having been present at the experiments.

John Millworth stated, that he had been employed to turn these machines. He could turn two breakers, two rubbers, and a hackling machine. It was tidy work, but he could do it for ten hours a day. He thought he could do 7 or 8 pounds of flax in an hour.

Mr. Lee then wished to call Mr. Bundy, with a view to establish, by his evidence, that these machines were infringements upon his patent; but this the Committee would not listen to, Mr. Curwen the Chairman stating, that this matter must be left to the consideration of a court of law. Mr. Samuel Hill was then called at the request of Mr. Lee, and stated in answer to the questions put to him, that his charge was 10*s*. a hundred weight upon the quantity produced, when the two processes were gone through. That he charged 2*l*. 10*s*. per ton for the use of the machine, 2*l*. for labour, and 15*s*. for the hacking machine.

Mr. James Lee being examined stated, that the quantity of fibres produced by his machines in ten hours, depended upon the number of persons working; thus two women at the

breaking machine, and one at the refining rollers, will produce 60 lbs. in a day, fit for the hackle. Some alteration had been lately made by the application of machinery. The expense will be the wages of the women; this is a farthing a pound for refining, and for breaking so much a hundred weight; which would make it come to less than a penny a pound, paying the women from 6 to 10 shillings a week. Mr. Lee then stated, that he had never done this quantity by the breaking machine, but he had done it by the other.* That a woman working by the other, and working the number of machines she can work, will finish from 50 to 100 pounds a day, according to the goodness of the flax. That he had never heard complaints made of the breaker injuring the fibre, unless it was injudiciously used. That some caution was necessary in using it, but very little; and he then enumerated the machines he had at work in the workhouses of St. Pancras, Hackney, Kensington, Westham, The Refuge for the Destitute, and at Hull, in Yorkshire.

Elizabeth Wilson stated, that she had worked Mr. Lee's machines, and instructed others for 12 months; that she had done a pound of flax in an hour, by the breaking and scraping machines; that at Hull, three or four of the machines do 11 lbs. a day; that many of them do 9, and none less than 7 lbs. a day.

Sarah Smith stated, that she worked at Mr. Lee's machi-

* Meaning the fluted rollers. To comprehend Mr. Lee's evidence and the following witnesses, the reader is requested to refer back to p. 333 of our last Number, where his machinery is described, and where it will appear that the work alluded to, is simply putting the flax in between the rollers and taking it out again; while those rollers would be completely ineffective unless they were moved by wind, water, steam, or some considerable power. This, therefore, is merely attendance upon the machine, and not a word is mentioned about the expense of the power, or its necessity; while in the account of Hill and Bundy's machines, the man's power to produce motion is always admitted. We hope that the information contained generally in this evidence, and the account of the machinery given in our last Number, will enable the public to estimate the important advantages likely to accrue to the nation, from the new process of husbanding and manufacturing flax, and to form a pretty accurate judgment of the respective values of the machines of Messrs. Hill and Bundy, and Mr. Lee.—Editors.

nery, did 8 lbs. an hour generally; thought she could do 12 lbs. if the flax was dry and good; could keep at it all day, was paid 12*s*. a week, and worked 11 hours daily; she had passed 70, 76, and 79 lbs. through the refining machinery in a day. There was not a bit of labour in it; a girl of 12 or 13 years old could have done it as well as herself. She served 18 refining machines. There was machinery at Merton to enable her to do this. (Mr. Lee here remarked, that the refining machinery worked by water, and that steam was to be applied in addition to that, to increase the quantity.) Witness continued that her work was merely to feed the machine, and to form the flax into a skain,* and to take it out again.

Art. IV. *Remarks on the natural Family of the Grasses. From the Latin of* Alexander *Baron von* Humboldt. *Paris,* 1817.

I have, in a former part of this work, classed the Orders *Gramineæ* (Grasses), *Cyperaceæ* (Club-rushes), and *Junceæ* (Rushes), in one natural family, under the denomination of *Glumaceæ* (the plants with a chaffy flower), and shall now proceed to a summary notice of the species, in regard to number, configuration, and geographical distribution. We may form a conception of the richness of America in plants of this nature, and of the smallness of the proportion of those which had come to the knowledge of the botanists of Europe, when we find, that of 343 species, observed by M. Bonpland and myself in the course of our travels, scarcely a fifth or sixth part had been recorded. In casting up the *Glumaceæ*, enumerated in Persoon's Synopsis Plantarum, those found by Mr. Brown in New Holland and Van Diemen's Island, and the new ones published by myself and fellow-traveller, we find that we are now acquainted with about 1200 *Gramineæ*, 900 *Cyperaceæ*, and 100 *Junceæ*, forming a total of 2200 *Glumaceæ*.

* This was shewn to be by uniting the two ends of the quantity used.

But, although this may appear a considerable number, and one that has, of late, received very extensive additions, it turns out, in fact, to be a proof of the negligence of botanists in respect to these three orders. It has been already shewn, that these three orders form one-tenth part of the Phænogamous vegetation of the earth; so that, in the 30,000 Monocotyledonous and Dicotyledonous species, which have been recorded, we ought to have met with, at least, 3000 *Glumaceæ*, if they had received from travellers an equal share of attention, with that which has been bestowed upon *Compositæ* and *Leguminosæ*.

All over the world the *Glumaceæ* are found to increase their number in a wonderful proportion, either as you recede from the line, towards the poles, or as you ascend the mountain, from the level of the sea. But then this augmentation of number takes place in a far smaller ratio, from the line to the temperate zone, than that in which is found to take place from the latitudes of France and Germany, towards the polar circle. In Lapland, for instance, there are three times more *Glumaceæ* than *Compositæ;* while, in the temperate parts of Europe, the families are nearly equal. On the other hand, in North America, from the 32d to the 45th degree of latitude, the *Compositæ* are already found to exceed the *Glumaceæ* by a fourth: a proportion which becomes still greater in the tropical regions of that continent. I have purposely taken the *Glumaceæ* and *Compositeæ* for points of comparison, as being the two families which, in every part of the world, comprise the largest portion of vegetable species, and display the greatest variety of configuration. Next, in point of numbers, to the *Glumaceæ* and *Compositæ*, as far as I am able to judge, are the *Caryophylleæ*, *Amentaceæ*, and *Ericinæ*, in the frozen zone; the *Leguminosæ*, *Cruciferæ*, and *Labiatæ*, in the temperate zone; the *Leguminosæ*, *Rubiaceæ*, and *Malvaceæ*, in the torrid zone.

In considering, separately, the three natural orders which compose the family of the *Glumaceæ*, we shall find, that the respective relations of the *Gramineæ*, *Cyperaceæ*, and *Junceæ*,

under the line, are, to each other, nearly, as 25.7.1; in the temperate latitudes of the old world, as 7.5.1; under the polar circle, as $2\frac{2}{3}$. $2\frac{1}{3}$. 1. So that it is only in Lapland that the *Cyperaceæ* are equal, in number of species, to the *Gramineæ;* but through the temperate zone to the tropics, the quantity of *Cyperaceæ* and *Junceæ* diminishes, in a far greater proportion, in the northern hemisphere, than that of the *Gramineæ:* in so much, that the *Junceæ* disappear almost entirely in the torrid zone. The *Cyperaceæ,* on the other hand, seem better qualified to support every degree of climate; and it is specially among them that we find the plants which are common to both the new and the old continents, such as *Kyllingia monocephala,* CYPERUS *monostachyus,* CHÆTOSPORA *aurea,* and other species, which we have enumerated elsewhere. So New Holland and South America produce, in common, SCIRPUS *triqueter,* SCIRPUS *capitatus,* and FUIRENA *umbellata;* Europe and Australasia, SCIRPUS *fluitans,* SCIRPUS *supinus,* SCIRPUS *setaceus,* SCIRPUS *lacustris,* SCIRPUS *triqueter,* SCHŒNUS *mariscus,* CAREX *cæpitosa,* CAREX *Pseudo-Cyperus,* JUNCUS *maritimus,* and JUNCUS *effusus.* In general, the countries which lie within the tropic of Capricorn appear to abound in the CYPERACEÆ; for, of the 456 GLUMACEÆ of New Holland, described by Mr. Brown, 214 are ranked in the *Gramineæ,* and 200 in the *Cyperaceæ;* which proportion, if it be admitted as the true one of the relative distribution of these plants, is widely different from that which is exemplified in the tropic of Cancer.

As to what I have to offer in regard to the secondary groups or tribes, into which the *Glumaceæ* have been divided according to natural affinity, I shall make use of an extract from the writings of Mr. Kunth: "Some of the tribes of the *Gramineæ,* are represented by numerous species in the tropical regions, while in Europe they have not a single species, or at least, such only as are very rare; for instance, the *Paniceæ, Stipaceæ, Chlorideæ, Saccharinæ, Orizeæ, Olyreæ,* and *Bambusaceæ.* Europe does not produce a single species of *Paspalum,* only five species of the *Stipaceæ,* very few of the *Saccharinæ,* but one of the

Oryzeæ, (Leersia *oryzoides*,) and not one of the *Chlorideæ*, *Olyreæ*, and *Bambusaceæ*. On the other hand, the *Agrostideæ*, *Avenaceæ*, *Arundinaceæ*, and *Bromeæ*, are peculiar to our temperate latitudes. In a like manner the *Hordeaceæ*, (an order which comprehends the principal part of our corn-plants,) seem specially adapted to the warmer regions of Europe and to Asia, while the alpine grasses of both the new and old continents belong principally to the *Agrostideæ*, *Avenaceæ*, and *Bromeæ*. The genus *Cyperus*, is almost entirely tropical; for of the 150 species, which we know at present, scarcely 20 belong to Europe and the northern part of America. There is not a Mariscus, nor a Kyllingia in all Europe; nor is there any species of the true *Cyperaceæ*, (those with two ranked imbricated glumes), in the whole European continent. The *Scirpeæ* seem to be dispersed indiscriminately over every part of the globe, and of all the monocotyledonous plants, are those among which we meet with the greatest number of instances of species, which are common both to the new and old continents."

In regard to Bamboos, M. Bonpland and myself had the good fortune to meet with them in bloom twice, once on the banks of the Cassiquiare, (a branch of the Orinoco), and again near the plantation of El Muerto, in the province of Popayan, between Bugus and Quilichao. For though these tree-like canes cover the marshy lands of the new world to a great extent, and often attain the height of 50 or 60 feet, yet they very seldom flower there. Neither Mutis, who had explored so many *Guadales*, (as the marshes covered with Bamboos are called by the Creoles,) nor our friend Tafalla, who had accompanied Ruiz and Pavon in their well known botanical expedition through Peru, had either of them ever been able to procure the fruit or the flower of a Bamboo. On the other hand, in the East Indies these gigantic grasses are known to flower in such abundance, that according to Dr. Buchanan, the seed mixed with honey, is a common article of food in the Mysore country. The plant is there believed to bear fruit as soon as it has attained the age of 15 years, and to die immediately afterwards. It is distinguished by the natives of those parts into two sorts, one with a solid cane, called *Chittu*, and

which grows in dry places, and the other with a hollow cane, called *Doda*, which comes quicker to maturity, and grows in watery places.

Having procured some canes of a Bamboo (Bambusa *Guadua*) at Guaduas, in New Granada, we saw at once how deficiently and incorrectly the genus had been characterized in all our botanical works, and made it our first concern to take the description of the plant on the spot where it grew, and attended in particular to the deeply three-parted style, and the three scales which surround the parts of fructification, and were then denominated by us its triphyllous nectary. Loureiro is almost the only author who has described the style correctly in the asiatic species, (for example, in Bambusa *verticillata*).

The Bamboo is not so general in the wet lands of South America as has been usually thought. They are rather scarce, both in the Caraccas and New Andalusia, (if we except the vallies that lie between Cumanacoa and the town of San Fernando), and the marshy woods of Guayana, that line the banks of the Cassiaquiare and Atabasso. There are hardly any other on the shores of the Apure which runs through the province of Varinas, or on those of the Guainia, or Rio Negro. In all the parts of America which were visited by Bonpland and myself, we only found them common in those places which lay exposed to the setting sun. They abound principally in New Granada, where they constitute vast forests, and grow both in the sultry lowlands, between Turbaco and Mahates, as well as in the highland vallies, where the climate is more temperate; for instance, between the towns of Guaduas and Villeta, in Santa Fè de Bogotà; on the western declivities of the Quindu Andès, near Buenavista and Carthagena; on the bank of the Cauca (between Bugas and Quilichao, in Popayan); and, lastly, at the back of the volcanic mountain, Rucu-Pichincha, near the city of Quito; where a wide marshy level, covered with a close rank vegetation, extends through the province of Esmeralda, to the shores of the Pacific Ocean.

We found the Bambusa Guaduæ from on a level with the sea, up to the height of 860 fathoms; and what struck us was, that the highland plants of this species always contained

more water than those on the plains, although both grew in soils of equal degrees of humidity. In the highest stations (as from 600 to 900 fathoms) we only found them dispersed about in small bushes; but, in the level country, even as high up as 400 fathoms, they formed extensive forests. In general the plants which belong to the Bamboo tribe, may be reckoned among the gregarious plants (*plantæ sociatæ*). The Nastus* of the Isle of Bourbon, according to Bory St. Vincent, is a true subalpine grass, and never descends into the plains lower than to an elevation of 600 fathoms above the sea.

The water which is found secreted in the hollow of the American Bamboos has a somewhat brackish taste, but is not unpalatable. It is said by the natives to have an injurious effect upon the urinary passages. I could never detect any

* The genera Bambusa and Nastus, which most botanists of the present day have blended together, are to be distinguished from each other by the following cahracteristics:—In Bambusa the long subcylindrical ears comprize a great number of bipaleaceous(double-chaffed) flowers, of which the lower only are male ones. Each of these bipaleaceous flowers is inclosed by a calyx of two glumes, (husks). The manner of the inflorescence, and the form of the chaffs are nearly the same as in the Poæ, from which, however, the Bambusæ are sufficiently distinguishable by an arborescent haulm, by having six stamens, a deeply trifid style, and three scales that surround the parts of fructification. In the genus Nastus, on the other hand, the ear is oblong, compressed, and comprizes a fixed number of chaffs, which overlay each other in two rows, nearly as in the *Cyperaceæ*. Of these glumes, only the two upper ones enclose a flower like that of Bambusa, viz. one with a trifid style, six stamens, and three nectaries. Judging from analogy, the two lower glumes may stand for the calyx in Bambusa, the others may be looked upon as neutral flowers with only one valve. The species which belong to Bambusa are, *arundinacea et stricta* Roxb. *verticillata* Willd. *latifolia et Guadæ*, Bonpl. and an unpublished one of the Isle of Bourbon. To the genus Nastus belong, *Calumet des hauts de Bourbon*, and a Madagascar, species of which the specimen is preserved in the Herbarium of M. Du Petit Thouars. Bory St. Vincent has described the style and nectaries of Nastus correctly, but has blended the genus with Bambusa.

secretion from the American Bamboos, that gave me any idea of the sweetness of honey, but I met with the true *Tabasheer* or *Tabaxir* in the kingdom of Quito, and it differed but very slightly from that of the East Indies. I brought home a specimen of it, which was analyzed by the celebrated Vauquelin. It is called by the Creoles *manteca de Guaduas*, (Guaduas, butter), and contains 0,70, of siliceous earth, and 0,30 of potash, lime, and water.

I cannot account for the *Tabasheer*, which is a white substance, and friable like starch, having been compared to honey by those who have treated on the subject of the sugar of the ancients. I could perceive no sweet taste in the Quito Tabasheer, not even when it was in the state of a mucilage, and before it was hardened by drying; and strongly suspect that none of the arborescent canes in all America contain any sweet liquid whatever. As to the Tabasheer, before it coagulates into its wonted stony hardness, it is a viscid, white, and milky substance. Kept for five months, it exhales a strongly fetid animal smell. The same property was observed by Dr. Patrick Russell, the oriental traveller, in what he terms the *salt of the asiatic Bamboo*, while Garcias del Huerto, who resided for a long time at Goa, in quality of physician to the viceroy, is the only author who speaks of a sweet juice from the Bamboo. The ancients seem to have been led to confound true sugar with tabasheer in the first place, from both being the produce of a cane, and in the second from the Sanscrit word *sharkara*, which at this day (like the Persian *shaker* and the Hindustanée *schukur*) is used for our sugar, not properly meaning something which is sweet, but something that is lapideous and granulated, as we learn from Boppius, on the authority of Amarasinha. It is probable that the word *scharkàra* originally meant only tabasheer, (*saccar mombu*), but was subsequently transferred from similitude of appearance to our sugar from the smaller cane (*ikschu*, *kandekschu*, *kanda*). The word Bamboo is derived from *mombu*; and from *kanda* we get candy, (*sugar-candy*). In tabasheer we trace the Persian word *scher*, which means milk, in Sanscrit *kschiram*.

Pliny, as has been ingeniously demonstrated by Salmasius in opposition to Scaliger, clearly describes tabasheer of the Bamboo under the name of sugar, when he speaks of it as "a honey formed in canes, white like gum, crumbling between the teeth, found in lumps about the size of a filbert, and only used medicinally." Yet it is manifest from the verses of Varro, quoted by Isidorus, from passages of Theophrastus, Lucan, Solinus, and especially Strabo, on the authority of Eratosthenes, that the ancients had derived some notion of our sugar from the East Indies, and affirmed that it was obtained from canes without the assistance of the bee. But then they believed that a liquid of the sweetness of honey was expressed from the roots of the large kind of canes, confounding the root with the haulm, and the humble sugar-cane (SACCHARUM *officinale*) with the Bamboo, "a joint of which, when split asunder, they described as large enough to form a navigable bark." Others among them, as Seneca, Dioscorides, and Alexander Aphrodisæus, believed true sugar to be the morning dews of the canes, collected on the foliage of the plant. It is certain that the sugar-cane is indigenous in the neighbourhood of Almangar, in the East Indies, on the banks of the Euphrates, and at Siraf; but I suspect that in that part of Asia which was frequented by the Greeks, the plant was only expressed for the purpose of procuring a beverage for immediate use, and that the juice never could have been exported, owing to its tendency to ferment. So that I conclude, that hard sugar was unknown to the ancients,* and that when they speak of a solid sugar, they mean tabasheer or scharkara of Bamboo.

It may be hardly thought necessary that we should mention in this place, that before America was discovered by the Spaniards,

* The art of making sugar from the cane was not mentioned by any writers until the fifth century, and, as the learned Sprangell has first shewn, Moses Chorenensis, in describing the beauties of the province of Chorasan, mentions the valley of *Gundi-Saporem* "as a place where the precious sugar was made." I have proved in another place, that the manufacture of sugar was of the highest antiquity in China.

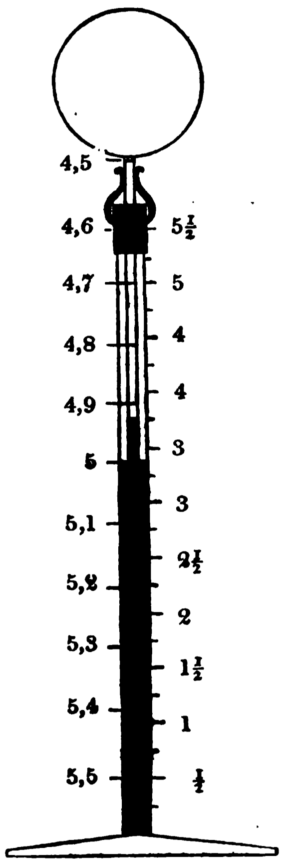
the inhabitants of that continent and the adjacent islands, were entirely unacquainted either with the sugar-canes, or with any of our corn-plants, (which last are indigenous of the country between the Kur and the Terek, in Persia and Armenia), or with rice. The Spanish writers on the subject of America, give the name of *small rice* (*Oryza parva*) to the CHENOPODIUM *Quinoa*, which is common in Santa Fè de Bagotá, and in the kingdom of Quito, in the same way as the Anglo-Americans did that of *Canada rice* to a species of ZIZANIA. Turkey corn, (ZEA MAYS), like many of the plants which have been in general cultivation from remote periods, is not found growing wild in any part of America. We have to lament that travellers have not made us correctly acquainted with the characters of the plants mentioned cursorily by Molina, in his history of Chili, under the names of *Secale Magu* and *Hordeum Tuca*, of which the Araucanos formerly made a bread called *couque*. We know from Cortes that the Agave and Turkey corn afforded the Americans a honey independently of the bee, and that he saw it in market at Tenochlitl.

ART. V. *Description of an Aërometer, for making the necessary Corrections in Pneumatic Experiments, for reducing the Volumes of the Gases to a given Standard. By* MARSHALL HALL, *M. D. &c.*

IN experiments on the Gases, it is generally necessary to make a correction, in order to ascertain their mean bulk; for changes in the temperature of the atmosphere, in the barometrical pressure, in the external and internal heights of the fluid of the pneumatic trough; and, when this trough contains water, for the elevation or precipitation of aqueous vapour, from these causes. And, in delicate experiments, it is frequently desirable to ascertain whether any slight change in the volume, or apparent quantity of the gas, be owing exclusively to the agency of an external cause, or whether there be an absorption, or evolution of gas, by the materials subjected to the experiment.

To obtain these corrections, it is usually proposed to make

three or four separate calculations; and a formula for each of these is given in the elementary works on Chemistry. It is the object, however, of the present communication, to describe an instrument, by the aid of which the necessity for these calculations may be superseded. This instrument, which may be termed an Aërometer, consists of a bulb of glass, four cubic inches and a half in capacity, attached to a long tube, whose capacity is one cubic inch. This tube is inserted into another tube, of nearly equal length, and supported on a stand, in the manner represented in the annexed figure.



The first tube admits of being sustained within the second, at any given height, by means of a spring, by which it is embraced, and which is fixed to the upper part of the external tube. Five cubic inches of atmospheric air, under a medium pressure, and in a medium temperature, are to be introduced into the bulb and tube, of the latter of which it will occupy one-half; the other half of this tube, and part of the tube into which it is inserted, are to be occupied by the fluid of the pneumatic trough, whether water or mercury. The point of the tube, at which the air and fluid meet, is to be marked by the figure 5, denoting five cubic inches by measure; the upper and lower halves of the tube are each to be divided into five parts, representing tenths of a cubic inch. The external tube is to be marked by a scale of inches, like the common carpenter's rule.

It is manifest that the condition of the gases, made the subject of experiment, as affected by external temperature and pressure, and by the formation or precipitation of aqueous vapour, when water is contained in the pneumatic trough, will be precisely similar to that of the air contained in the Aërometer. Now, if the height of the fluid of the pneumatic trough be different from that of the fluid within the jar, this difference is to be measured, and a precisely similar difference is to be induced in the external and internal heights of the fluid of the Aërometer, by raising or depressing the tube of the Aërometer, in the tube containing it.

The gases made the subject of experiment, and the air contained in the aërometer, are now placed, in every point of view, in similar circumstances, and it is only necessary to compare them. If the volume of the air of the aërometer be increased or diminished, that of the gases subjected to experiment may be concluded to be affected in a similar and proportionate manner. The air of the aërometer becomes, therefore, the point of comparison, and the measure of the gases in the pneumatic jar. Let *a* be the volume of the air contained in the aërometer, and *b*, that of the gases, on which the experiment is made: then

$$a : 5 :: b : x =$$

the real volume of the gases, under a medium pressure, and in a medium temperature.

By this simple comparison of the volume of air of the aërometer, with that of the contents of the pneumatic jar, the real quantity of the gases made the subject of experiment is at once ascertained, according to the standard originally adopted; and the necessity for several calculations, and for references to the table of the changes of volume of the gases, by given changes in temperature, are at once obviated and superseded.

Art. VI. *On some curious Properties of the Powers of Numbers.*

To the Editor of the Journal of Science and Arts.

Sir,

A few years since considerable attention was excited by an American boy, who performed mentally several arithmetical operations of some difficulty, such as discovering the factors of which any number consisted, extracting the square and cube roots, &c. Having myself been present at some of his performances, I was led to consider the means by which several other arithmetical operations of, at least, equal difficulty, may be performed with facility, without the aid of writing. I have subjoined a few of the rules which occurred to me in the enquiry; and, if you deem them worthy of a place in your valuable Journal, they are much at your service.

I remain, yours, &c.

D. O.

Given any number, which is a complete power of 2, to discover at sight what power it is, or how many times the number 2 has been multiplied together, and produce the given number.

Let $p + 1$ be the number of figures in the given number. Subjoin to the right-hand of p,

$$\text{the number } \left.\begin{matrix}0\\3\\5\\6\\7\\8\\8\\9\\9\end{matrix}\right\} \text{ if the given number begins with } \left\{\begin{matrix}1\\2\\3\\4\\5\\6\\7\\8\\9\end{matrix}\right.$$

2dly, Then the nearest whole number to one-third of the result, will be the power to which 2 has been raised, to produce the given number.

Ex. 1. What power of 2 is 2048?

Here the number of figure is 4; therefore

$$p + 1 = 4, \text{ and } p = 3.$$

Since the given number begins with 2, we must subjoin 3 to the right side of p, when it becomes 33,

$$\text{one-third of which is } \frac{33}{3} = 11;$$

consequently 2048 is the 11th power of 2.

Ex. 2. What power of 2 is 4611686018427387904?

In this case the number of figures is 19; therefore

$$p + 1 = 19, \text{ and } p = 18;$$

And since the given number begins with 4, we must subjoin 6 to p, when we have 186;

$$\text{one-third of this is } \frac{186}{3} = 62;$$

the given number is, therefore, the 62d power of 2.

The investigation of this rule is very easy:

$$\text{Let the number given be } N = A^n,$$

by logarithms we have

$$\log. N = \log. A^n = n \log. A;$$

And since the number of figures in N is $p + 1$, log. N is nearly equal to p, and the first decimal of log. N will depend on the figure with which N begins. If it begins with 2, it will be 3; if it begins with 3, the decimal part will be 5

nearly, and so on, as in the rule. Let k be any one of these numbers, then

$$\log. N = p + \frac{k}{10}$$

$$\text{and } n \log. A = p + \frac{k}{10}$$

$$\text{or} \quad n = \frac{10\,p + k}{10 \log. A}$$

When $A = 2$, $\log. A = \frac{3}{10}$ nearly, and the value of n is

$$n = \frac{10\,p + k}{3} \text{ nearly,}$$

as we have given in the rule.

Given any number, which is a power of 4, to ascertain what power it is.

Rule.—Proceed exactly as in the first part of the former rule; and, for the second part,

Take the nearest whole number to one-sixth of the result, which will be the power to which the number 4 has been raised.

Ex. 1. What power of 4 is 256?

Here $p + 1 = 3$, and $p = 2$.

And since the given number begins with 2, we must subjoin 3; hence

$$\frac{23}{6} = 4 \text{ nearly;}$$

and 256 is, therefore, the 4th power of 4.

Ex. 2. What power of 4 is 1152921504606846976?

In this case $p + 1 = 19$, and $p = 18$;

$$\text{hence } \frac{180}{6} = 30,$$

and the given number is the 30th power of 4.

The investigation of this rule easily follows from that of the former; for

$$n = \frac{10\,p + k}{10 \log. A}$$

And A, in this case, is equal to 4, consequently log. $A = \log. 4 = \frac{6}{10}$ nearly: hence

$$n = \frac{10\,p + k}{6}$$

This rule is not quite so extensive as that which was given for the powers of 2; the reason of which is, that $\frac{3}{10}$ is more nearly equal to the logarithms of 2, than $\frac{6}{10}$ is to that of 4.

Given any number, which is a power of 5, to determine on inspection what power it is.

Proceed exactly, as in the two former rules, for the first part, and take the nearest whole number to one-seventh of the result; this is the power to which 5 has been raised.

Ex. What power of 5 is 15625?

Here $p + 1 = 5$, and $p = 4$;

$$\text{hence } \frac{40}{7} = 6 \text{ nearly,}$$

and 15625 is the 6th power of 5.

This rule is easily proved by the formula already given, if we substitute in it $\frac{7}{10}$ which is nearly equal to the logarithm of 5: it then becomes

$$n = \frac{10\,p + k}{7}$$

Any number, which is a power of 9, being given to ascertain by inspection what power it is.

All powers of 9 end either with 1 or with 9.

$p + 1$ being the number of figures in the given number, let t be the number of times 10 is contained in $p + 1$, and let l be the last figure but one of the given number: then,

If the given number ends with 1, it is the $(10\,t + 10 - l)$ power of 9, except $l = o$, when it is simply the $10\,t$ power of 9.

If the given number ends with 9, it is the $(10\,t + l + 1)$ power.

Ex. 1. What power of 9 is 282429536481?

Here $p + 1 = 12$, and 10 is contained in 12 once; therefore $t = 1$, also $l = 8$: hence

$$10\,t + 10 - l = 10 + 10 - 8 = 12,$$

and it is the 12th power of 9.

Ex. 2. What power of 9 is 4782969?

In this case we have $p + 1 = 7$, and 10 is not contained in 7; therefore $t = o$, also $l = 6$: then

$$10\,t + l + 1 = 6 + 1 = 7,$$

and the given number is the 7th power of 9.

The investigation of this rule may easily be deduced, from considering the expansion of

$$9^n = (10 - 1)^n.$$

If, however, the number, which is a power of 9, contains less than 22 places of figures, we may employ a shorter rule; for, in that case, the number of the figures it contains will be equal to the power to which 9 has been raised; thus 729 contain 3 figures: it is the 3d power of 9; so also 59049 consists of 5 figures, and it is the 5th power of 9.

Any power of 11 being proposed, to discover on inspection what power it is,

Take as many tens as there are contained in the number of figures, of which the given number consists, and add to them the last figure but one of the given number: the sum is the power to which 11 has been raised.

Ex. What power of 11 is 14641?

The number of figures is 5, in which 10 is not contained, and the last figure but one is 4: therefore 14641 is the 4th power of 11.

These rules are, of course, only applicable to perfect powers of the respective numbers to which they relate, and there is considerable difference as to the extent to which they continue true; thus the 2d rule, given for the powers of 9, fails in the 23d power: whilst the rule for discovering the power of 11, will not, I believe, be found deficient for any power under the 240.

Art. VII. *Account of the Mineral Springs of Caldas de Rainha, in the North of Portugal, with an Analysis of the Water.* *By* George Rennie, *Esq.*

London, Feb. 18, 1818.

Caldas is a small town, celebrated for its baths. It is situated at the distance of fourteen Portuguese leagues from the north of Lisbon, in the province of Estremadura, and comprehended in the Ouvidoria de Alemquer, which includes the villages of Alemquer, Alde Galega, da Merciar, Caldas Chamusca, Cintra, Obidos, and Selir de Porto, comprising a population of 30,000 souls. The surrounding country is well cultivated, and agreeably diversified by gentle inequalities of surface. The soil, which is sandy, reposes on red sand stone, covering a coal formation. The surrounding hills have no considerable elevation, they consist of coarse red sand, and primitive limestones. The town, which is only remarkable for its baths approaches the figure of an irregular square, and annually, though slowly, augments. The houses are indifferently furnished, and the windows, for the most part unglazed. Living is expensive, and the essential luxuries of life hardly obtainable. The accommodations at the inn, are, however, good. The hot springs are in the centre of the town, and inclosed by a neat substantial building, which is entered from the principal or western side, into a square vestibule. A room on the left, constitutes a pharmacy. A dark vaulted passage conducts to the men's bath on the right, and a passage of about 30 feet long by 8 feet wide, connects the well-room with the vestibule. The interior of the hospital communicates with the well room, where the water is administered by an attendant I tried the temperature of the water when fresh drawn, it was then 85° Fahr. in the tumbler, when lowered into the well it indicated a variation of from 88° to 90° Fahr. The emission of vapour and sulphureous smell appeared to augment and diminish, but observed no regular intervals.

The smell and taste was similar to that of Harrowgate water, but accompanied with less sparkling. Its volatile parts dissipated by exposure to the atmosphere, and formed a thin pellicle of sulphur on the surface. The colour of a bright silver table spoon was sensibly changed when suspended in the vapour, and the surface of a penknife was readily acted upon when immersed in the water. Boiling entirely deprived it of smell. The water is taken internally from 7 to 10 in the morning and evening, which is usually the time for bathing. The company employ these intervals in promenading to the dismal light of two or three lamps. The utmost precaution is observed in protecting the body by warm cloathing, which is here very necessary. The insipidity of social intercourse, added to a total defect of public amusement, present no inducements to the residence of a stranger. The climate is subject to extreme variations of temperature, and the prevalence of violent winds in the spring, which blow uninterruptedly from the ocean. The excessive heat of the summer season in the day time, is succeeded by cold moist vapours in the evening, which render an exposure of the body extremely hazardous. On the 23d of August, the thermometer in the shade at mid-day, indicated 78° Fahr. and in the sun 115°, giving a difference of 37°. At midnight it was 44°, giving a difference of 34° between the temperature of mid-day and midnight. There are four baths appropriated to public use. But the principal one, or men's bath, is the one from which the sample was taken. It is 36 feet long, 9 feet wide, and about 2 feet 10 inches deep. It is enclosed by a spacious vaulted apartment. The spring oozes from the north-west corner, yielding upwards of 45 cubic feet per minute, calculating from the rise of water in the bath. A pump is placed in the source for the purpose of applying a stream on the different parts of the body. A thermometer plunged immediately into the source, indicated a temperature of from 93° to 94°, which agrees with the statement of Dr. Withering. The east end, which is most remote, varied by several degrees. A fine white sand over a stratum of argillaceous earth, covers the bottom

of the bath on which the bathers' sit. An inclined board admits of the requisite elevation to bring the chin on a level with the surface of the water. An attendant regulates the period of immersion according to the nature of the patient, and renders every assistance for a small gratuity, which is perfectly optional to the bather. An apartment properly heated, is appropriated to the general service of dressing and undressing, and the usual precautions observed before and after bathing. The women's bath is about the same size, but from the room being larger, the average temperature of the bath is lower. The thermometer indicated the same temperature in the source. The product of the supply of the men's bath, is equal to the united products of this and the other two. The waste water of all the sources, is conducted westward into the cistern at the king's garden, where it serves the purpose of bathing cattle, and turning an horizontal water-wheel by the lateral impulse of the water, and as the wheel revolves with great rapidity, the prolonged axis of it moves the upper mill-stone with sufficient velocity. Most water-mills in Portugal are constructed upon this principle. The garden, or quinta, although in bad taste, is large and well kept. From May to September may be accounted the fashionable season. From vestiges of Roman antiquity discovered on the scite of the present establishment, it is probable, that the Romans were acquainted with the medicinal properties of these springs, but their history is involved in obscurity, until the marvellous virtues attributed to them attracted the notice and piety of Eleonor, (queen and consort of Dom John II.), who erected an hospital for the benefit of poor persons, in the year 1484, and hence the denomination of Caldas de Rainha, or Queen's Hot Baths. The first attempt at an analysis of this water was made at the university of Coimbra, in the year 1776, and afterwards by Dr. Nunez Gayo, in a memoir intitled Tratado da Ague de Caldas da Rainha, Lisboa, 1779, 8vo. The result of his experiments gave the following ingredients:

Iron, marine salt, *the elements of phlogiston,* selenites, fixed air, absorbent earth, argil.

Agreeing with the experiments made at Coimbra, with the exception of the presence of iron, not detected by that university, a small pamphlet was published in the year 1791, 4to, on the use and abuse of Caldas waters. "Advertencias sobre os abusos e legitimo uso dos Agoas mineraes dos Caldas da Rainha, por Francisco Tavares, Lisboa, 1791." Little information, however, can be derived from the above authorities, exhibiting throughout an imperfect knowledge of chemical science.

In the year 1795, a pamphlet was published by the celebrated Dr. Withering, of Birmingham, entitled, "Analyse da Agoa da Caldas da Rainha," &c. 61 pages, 4to. The work is entitled to much attention, as being the only considerable approximation hitherto made towards a knowledge of its component parts, but which this skilful naturalist was prevented from correctly ascertaining by the imperfection of his apparatus.

I remain your most obedient,

GEORGE RENNIE.

Dr. Withering's analysis of 128 oz, of the water is as follows:

Fixed air	-	$\frac{1}{4}$ oz. measure
Hepatic air	-	6 $\frac{1}{4}$ oz. measure
Calx aerata	-	3 $\frac{1}{2}$ grains
Ferrum Hepaticum		2 $\frac{1}{2}$ grains
Argil Earth	-	1 $\frac{1}{4}$
Siliceous Earth	-	0 $\frac{1}{4}$
Magnesia Salt	-	64
Selenitic Salt	-	44
Common Salt	-	148
		264 grains.

Some of the water brought to England was found to be of specific gravity 1005, 8.

16 ounces evaporated gave 24 grains of dry salts, and they were

Mur. Soda	-	12.2
Sul. Soda	-	5.5
Sul. Lime	-	4.1
Sul. Mag.	-	1.7
		23.5

ART. VIII. *Report of* Mr. Brande's *Lectures on Mineralogical Chemistry, delivered in the Theatre of the Royal Institution, in the Spring of* 1817. *Continued from page* 247 *of Vol. IV.*

THE mineralogical and chemical history of platinum, copper, and mercury, formed the subject of the next lecture. Platinum has been known in Europe for about a century. Don Antonio de Ulloa, who accompanied the French Academicians to Peru, for the purpose of measuring a degree of the meridian in 1735, is the first who formally announces it by name; and in 1754, its properties were very diligently examined by Dr. Lewis, and an account of them published in his "Philosophical Commerce of the Arts."

This metal may be considered as the exclusive product of South America, having been hitherto only found in New Granada, in the province of Barbacoas, near the shores of the South Sea, and in Brazil. Vauquelin indeed, has lately detected it in very minute quantities in the gray silver ore of Guadalcanal.

It occurs in small grains, very heavy, and of a silvery white lustre—these, however, besides platinum, contain a variety of other bodies. The pure metal may be procured by dissolving

the ore in dilute nitro-muriatic acid, precipitating by sa' ammoniac, and heating the precipitate to redness. Granulated platinum is thus obtained, which at a white heat may be welded into bars. It is a white metal, sp. gr. 22, very ductile and malleable. Dr. Wollaston, by the ingenious expedient of enveloping it in silver, has drawn it into wire, one two-thousandth of an inch only in thickness. It is very difficult of fusion, and a bad comparative conductor of heat and electricity; hence in the Voltaic circuit it sooner becomes red-hot than most of the other metals. The chemical properties of platinum were next shewn, the means of recognizing it in analysis pointed out, and the method exhibited of applying it to the surface of porcelain and earthen ware.

The chemist is the principal person who has been benefited by the discovery of platinum. Its power of resisting the action of heat, and of most acids, renders it very valuable for many purposes in the laboratory; there are, however, many bodies which unite with it at a moderate temperature, forming an easily fusible compound, and the introduction of these into vessels of platinum, must be carefully guarded against.

Although the metallic grains whence we obtain platinum consist chiefly of that metal, they also contain gold, iron, lead, generally mercury, and four other metallic bodies, which are of more recent discovery, and have been termed iridium, osmium, palladium, and rhodium. Of these, the two former were discovered by the late Mr. Tennant, and the two latter by Dr. Wollaston; and had we searched throughout chemistry for an illustrative instance of the delicacy of the modern art of analysis, it would be difficult to have found any one more notorious than the history of the discovery and separation of these bodies exhibits.

When crude platinum is acted on by nitro-muriatic acid, by far the greatest proportion is dissolved; but there remains a black powder, which was taken by Mr. Tennant as the subject of his researches, who found that by the alternate action of soda and muriatic acid, it might be entirely dissolved.

The *alcaline solution* distilled with muriatic acid gave a volatile metallic oxide dissolved in water, which from the peculiar smell, Mr. Tennant called osmium. The pure metal may be obtained by shaking mercury in the solution of the oxide, and distilling the mercury from the amalgam so formed; the metal is white, very infusible and fixed. With tincture of galls its solutions afford a blue precipitate.

The *acid solution* contained another metal called iridium, on account of the various colours exhibited by its oxide.

Dr. Wollaston principally turned his attention to the solution remaining after the precipitation of the platinum by sal ammoniac. This may contain iron, copper, lead, gold, platinum, and two new metals. These different substances are separable by a plate of iron, which, when immersed in their solution, throws down every thing except iron. This precipitate is digested in weak nitric acid, which dissolves the lead and copper; then in nitro-muriatic acid, which takes up the platinum, and the remaining two metals. The addition of common salt forms triple compounds with each of them. Alcohol dissolves two of these, and leaves a triple salt of a metal which produces red saline compounds, and which Dr. Wollaston thence called *rhodium*.

The alcoholic solution contains the salt of platinum, which we may set aside, and another salt, containing the remaining new metal *palladium*, which is separable by prussiate of mercury; or palladium may be at once precipitated, by adding prussiate of mercury to the solution remaining after the precipitation of platinum by sal ammoniac. Rhodium is a white metal, its specific gravity 11. Palladium is a little heavier. Palladium alloyed with gold has been employed, at the suggestion of Dr. Wollaston, for the graduated part of the great astronomical circle, erected at the Royal Observatory, by Mr. Troughton.

A separate ore, consisting of iridium and osmium, has been discovered by Dr. Wollaston among the grains of crude platinum. Its specific gravity 19,5; it is hard, not malleable, and very brilliant.

I have thus endeavoured to describe, and as far as their nature admits, to exhibit the analytic processes by which the various substances existing in crude platinum are separable, as well as the characters which enable us to recognise them as distinct and peculiar bodies. The separation of the new metals from this complicated mixture, may be considered as one of the great triumphs of modern analysis, and sets the skill and dexterity of the discoverers in the strongest light; for they had not merely to disunite a compound of known elements, but were further perplexed by the unknown characters of the new and unexamined metals.

The case before us will also serve to give those who know chemistry by name only, some notion of the difficulties which beset the chemical analyst, and of the patience and knowledge required to overcome them; for these persons often imagine, that making a chemical analysis is a very simple process; they have been in the habit of looking at results, but have neglected the steps that led to them; forgetting, as Lord Bacon has somewhere said, "that in philosophy as in husbandry, a few hands suffice to measure out and fill into sacks, that corn which requires very many more labourers to sow, and reap, and bind, and bring into the barn."

We now pass on to another metal—mercury or quicksilver, of which there is but one ore of any consequence: the sulphuret called also *cinnabar* or *vermillion*. It occurs crystallized, and massive; light and dark red, and often sprinkled with globules of metallic mercury. This ore has been found in France, in the department of Mont Tonnerre, and in other parts of the kingdom; but the most celebrated European mines are those of Almaden, in Spain.

The Spanish dominions in America are also very rich in quicksilver, and large portions are annually prepared for the purposes alluded to in my last lecture. In the kingdom of New Granada, a large vein was discovered by *shodeing*, that is, by traceing the fragments of ore washed down by currents to their source. Quicksilver, geologically speaking, stands among the newest metals. In primitive countries it occurs only in

small quantities, and is rare; but in bituminous slate, shell lime-stone, sand-stone, and breccias, the great repositories exist. It has been found by Dolomieu among volcanic products, doubtless sublimed by subterranean fires.

There are two leading processes by which quicksilver is obtained in its metallic state. In France, cinnabar is distilled with lime and iron, by which it is decomposed, and the quicksilver passes over. In Spain, it is procured by roasting the ores: of these, and indeed of most other metallurgic processes, an excellent account will be found in Aikin's chemical dictionary.

This ore of mercury is easily known by being wholly dissipated with a sulphureous smell before the blowpipe. It is used as a pigment, and for colouring red sealing wax.

Quicksilver is a metal presently recognised by its fluidity. It boils at + 660°, and freezes at—40°. It forms two oxides; the protoxide is black, and contains 190 metal + 7,5 oxygen: the peroxide is red, and consists of 190 metal and 15 oxygen.

There are also two chlorides. The one commonly called calomel, and composed of 190 quicksilver and 33,5 chlorine. The other is corrosive sublimate, and contains 190 quicksilver, +67 chlorine. The modes of forming these two very important compounds were exhibited; and Mr. Brande took the opportunity which was thus afforded, of shewing the fallacy of the notions which some have entertained respecting the compound nature of chlorine.

After shewing the nature of the salts of mercury formed by the two oxides, Mr. Brande proceeded to the metal copper, of which the ores were more numerous, and the processes of reduction more complicated than those of the metals before noticed. It is found native, combined with oxygen and with chlorine; in the state also of carbonate, arseniate, and phosphate; and lastly, united to sulphur. Specimens of these ores were shewn, and their mineralogical and chemical characters were dwelt on at some length.

The ores of copper are mostly peculiar to the old or primitive rocks. In this country, Cornwall not only furnishes profusion

of the useful ores, but the most select and scarce cabinet specimens—such as native copper, black sulphuret of copper, and arseniate of copper.

Blue carbonate of singular beauty is found at Chessy, in France. Malachite, or green carbonate of copper, in Siberia. It is used in China as a common green paint, and for ornamental purposes. The most considerable mines in the world are those of Cornwall and Anglesea. Russia, Austria, and Sweden, are also rich in this metal.

There is no metal, the presence of which is of more easy detection than copper. The suspected mineral is to be powdered, and boiled in dilute nitric acid, when it either affords a blue solution, or one which becomes so by the addition of ammonia. Solutions of copper furnish a precipitate of metallic copper, when a plate of clean iron is immersed in them.

The ores of lead met with in the cabinet of the mineralogist are very numerous; but those which are really useful as sources of the metal are few.

Those ores of lead which are not of a metallic appearance, have a vitreous or greasy looking fracture; and they are easily reducible by the blowpipe, when mixed with charcoal and some proper flux. The evidence respecting the existence of native lead, is by no means good. Mr. Rathkié is said to have found it in Madeira, but it has been there considered as of volcanic origin.

Native oxide of lead is also a very scarce ore; it is of a red colour, and generally associated with sulphuret, from the decomposition of which it probably results. It has been found in Yorkshire, and in some of the German lead mines.

Chloride of lead, called also horn-lead, has been found in Derbyshire, Germany, and in the United States by Dr. Meade; it is a very rare ore.

Carbonate of lead commonly occurs crystallized in 4 and 6-sided prisms, and in long acicular and capillary crystals, aggregated into a columnar form. It is a soft, brittle, and heavy ore, and easily furnishes a metallic globule by the blowpipe.

It generally contains about 90 per cent. of carbonate of lead, and 10 per cent. of silica, alumina, and oxide of iron. Grey-wacke, slate, and lime-stone rocks, are the usual containers of this ore; other lead ores and copper ores usually accompanying it. It is found in Lanarkshire, Durham, Cumberland, Shropshire, and in Cornwall, of singular beauty in Pentire-glaise, in the parish of St. Minver. The mines of Saxony, Siberia, and of Chili in America, have also produced splendid specimens. Its chemical character is solubility in nitric acid, with effervescence. The solution affords a precipitate of metallic lead by the immersion of a plate of zinc.

Phosphate of lead, or *green* lead ore is crystallized in six-sided prisms, and short diverging acicular crystals. Before the blowpipe it melts into a polyhedral globule. Yorkshire, Scotland, Germany, and Siberia, afford fine specimens. One variety is *brown*, and occurs massive and crystallized; it is found in Hungary, Saxony, and very fine in Huelgot, and Poullouen, in Brittany; also in Mexico.

Arseniate of lead is a rare mineral. There are two varieties, the filamentous and reniform; it has a brownish colour. Before the blowpipe it exhales arsenic and leaves lead. Hitherto it has been found only in France and Siberia.

Sulphate of lead has a grey colour, and when crystallized assumes the forms of octohedra and four-sided prisms. It decrepitates under the blowpipe, and gives metallic lead. It is found in Anglesea, Scotland, Cornwall, the Hartz, and Siberia.

Molybdate of lead, or yellow lead ore, crystallizes in modified octohedra, and tables. It was analysed by Mr. Hatchett, in the year 1796. It is found in Carinthia, the Tyrol, and Mexico.

Chromate of lead, or red lead of Siberia, crystallizes in four-sided prisms, &c. It is of a fine reddish yellow colour, and has lately been artificially prepared by Dr. Bollman, and advantageously employed in the arts.

These ores of lead are chiefly to be recognized as chemical and mineralogical varieties; they are highly interesting and

curious as specimens, but of little value as sources of this useful metal, which is almost exclusively drawn from the *sulphuret* or *galena.*

This ore is distinguished by its metallic lustre, and its foliated fracture. It is soft, heavy, and brittle; its specific gravity 7.5. It is very commonly crystallized in cubes, octohedra, and prisms. Before the blow-pipe it exhales sulphur, and gives a globule, which by the joint action of heat and air disappears, provided the lead be pure. It contains 87 of lead and 13 of sulphur.

This ore of lead occurs in primary as well as in secondary rocks; in this country our richest mines are in slate and limestone. And such is the recent deposition of lead in some cases, that it is actually found within the cavities of shells. Great Britain presents us with the richest lead mines of the known world; they furnish more than half of the lead annually raised in Europe which amounts to about 500,000 quintals.

The mines of Northumberland, Durham, Derbyshire, and Somersetshire are chiefly in limestone. In Devonshire it is found in slate; as at Beeralston upon the Tamar. Fluor spar is a very common accompaniment, of which some interesting mineralogical varieties occur at Beeralston. Lanark, Dumfries, and Aberdeen are the principal Scotch shires rich in lead. The mines of France, Westphalia, Austria, Spain, and Prussia are the next in importance. Those of Saxony, Bavaria, and Russia are of little consequence. It is probable that China is rich in lead.

The reduction of the sulphuret of lead to a metallic state is a sufficiently simple process. The ore is broken up and freed as much as possible from extraneous matters, or dressed; it is then ground or broken finer, and thrown in quantities of about a ton at a time into a reverberating furnace. The flame of pit coal is made to play upon it, it soon gets red hot and melts; the fire is then slackened till the mass gets dull red, and the sulphur then evaporates; quick lime is thrown in, and a separation is soon observed into lead and slag; the metal is then drawn out.

Galena often contains silver; and although there is no method of ascertaining this but by analysis, we observe it generally impairs the lustre of the ore. When the quantity of silver is extremely minute it is not worth separating, and hence, the lead of commerce often contains it; but when it amounts to about 12 or 14 ounces per ton, then the processes become more complicated and curious to obtain it. The richest argentiferous lead of this country, which I remember to have heard of, is that of Brunghill moor in Yorkshire, yielding=230 ounces per ton. In the reign of Charles I. the mines of Cardigan gave 80 ounces per ton. The leads of Durham and Westmorland about 17 ounces.

Mr. Brande proceeded to describe the process of reduction by cupellation, and the mode of separating the silver:—

The process of cupellation is often performed with a very different intent, as in the analysis of ingots of gold and silver, containing certain quantities of copper or other base alloy. This analysis is commonly called *assaying*, and rests upon the property which lead has of not merely being converted into a fusible glassy oxide itself, when exposed to heat, but when in that state of dissolving, and oxidizing the copper, or other base metals.

Pure lead has a bluish white colour, and much inherent lustre, but soon tarnishes. Its specific gravity is 11.3. It is malleable, but little tenacious, and melts below a red heat. It combines with oxygen in three proportions, forming *massicot* or yellow oxide, *minium* or red oxide, and the peroxide is of a brown colour.

In these combinations 97 parts of the metal are respectively united to 7,5 — 11,25 and 15 of oxygen. All the salts of lead contain the first oxide.

Copper and lead are metals much used for domestic and culinary purposes, and as it not unfrequently happens that articles of food, as well as water, are tainted by their combinations, and thus rendered pernicious to health, it will be right, in this place, to say a few words of the means by which they may be detected.

Copper vessels are easily acted upon by weak acids, or even

by the joint action of air and water; hence, any vegetable matter either sour, or having a tendency to become so, may become very deleteriously tainted. This not unfrequently occurs with pickles and sweetmeats, and will almost always happen when any kind of food is left for some time in a copper saucepan not perfectly tinned. In these cases the presence of copper may be detected by ammonia, and by a plate of iron.

Lead is by no means an unfrequent ingredient in water, which, according to the custom of this country, is preserved in leaden cisterns, and conducted through pipes of the same metal; although it does not at all follow that on this account the water should be *necessarily* tainted. Where the water contains carbonic acid in any quantity, it will be apt to have carbonate of lead mechanically suspended in it. It is very rarely the case that lead is in a state of solution in the water; so that in examining a suspected water, the sediment as well as the clear water must be attended to. The best tests for lead, are sulphuretted hydrogen, which gives a brownish black precipitate in solutions containing lead; hydriodate of potash forms a yellow precipitate; sulphate of soda a white one, which heated before the blowpipe on charcoal affords a globule of the metal.

Much has been said concerning the addition of sugar of lead to wines, and an idea has often gone abroad that white wines are frequently adulterated with this pernicious compound; that it is used to counteract tartness. I have examined more than 100 samples of white wine of different kinds and from different sources, with a view of ascertaining the truth of this opinion: in two instances only I discovered lead: in one case it was in very large quantity, but there was good evidence of the wine having been put into a bottle which had previously contained goulard water; in the other case, lead was observed only by very nice tests and in very small quantity, and it arose from some shot having been left in the bottle, a very minute portion of which had been dissolved by the acid of the wine. So that the apprehension which some have entertained concerning the frequent and intentional adulteration of white wines with sugar of lead seems to be perfectly groundless.

VIII. *On some Combinations of Ammonia with Chlorides. By M.* Faraday, *Chemical Assistant in the Royal Institution.*

It has been already shewn, particularly by Sir H. Davy, that several of the binary compounds of chlorine, as those of phosphorus, tin, &c. exert a strong affinity for ammonia, condensing it when in the gaseous state, and neutralizing its alkaline properties. The combinations which will here be offered to notice, are of a different kind, and if they deserve any attention, it will be in consequence of the weakness of the power which is exerted in their formation, and the slight change of properties induced on the substances by union.

It has been frequently observed by chemists, that if well fused muriate of lime be placed in ammoniacal gas, there is a rapid absorption of the gas, and the chloride becomes covered with a white powder. If ammonia be repeatedly added until the absorption ceases, the mass of chloride swells, cracks, splits in all directions, and at last forms a white pulverulent substance.

Exposed to the atmosphere, it deliquesces, but not so rapidly as muriate of lime. Thrown into water it dissolves, forming a strong alkaline solution. Heated, it gives off ammonia, and the chloride remains unchanged. Placed in chlorine it inflames spontaneously, and burns with a pale yellow flame.

The fused chlorides of barium and strontium suffer a very slight change in ammoniacal gas in many days; after more than a fortnight the chloride of strontium, weighing about 30 grains, had absorbed only a cubical inch of gas, and a slight efflorescent appearance was seen on the broken edge.

A piece of fused chloride of silver, weighing about 30 grains, placed in ammoniacal gas, gradually absorbed more than 40 cubical inches. The action took place over the whole surface of the mass, but most speedily at the fractured edges. The chloride swelled considerably, and crumbled into powder. The substance formed was at first white, but it blackened by

exposure to light, though without liberating any gas. Thrown into water the ammonia was separated, forming a solution, and the chloride remained unchanged. Heated, the whole of the ammonia was given off. Placed in clorine it inflamed spontaneously, and the ammonia was decomposed.

Chloride of silver that had been well dried, but not fused, gave the same compounds with ammonia, but in a much shorter time.

A strong solution of chloride of silver in ammonia was left for some weeks in a bottle stopped only by a piece of paper. At the end of that time several perfectly colourless and transparent crystals had formed in it; some of them being as much as a quarter of an inch in width. Their general form was that of a flat rhomboid, but sometimes two acute angles of the rhomboid were wanting, and then the crystals looked like hexaedral prisms with oblique bases.

Exposed to the air, these crystals became opaque, gradually loosing the whole of the ammonia, and were then so friable as to fall into powder by a slight touch; the substance remaining was a dry chloride of silver. Placed in water, the same change occurred, but more readily, the water separated the ammonia, and they instantly become opaque. Heated, they gave off much ammoniacal gas, and the chloride remained unaltered. Exposed to light, they gradually blackened, though covered by the solution from which they were deposited.

If the ammoniacal solution be weak, other crystals are formed which are pure chloride of silver.

Dry corrosive sublimate placed in ammoniacal gas had suffered no change in fourteen days, nor had any action been exerted on the ammonia; there was a diminution of a quarter of a cubical inch of gas, probably owing to a little water being present. The corrosive sublimate heated gave out no ammonia, and the whole of the gas remaining was absorbed by water.

The precipitate obtained by adding ammonia to a solution of corrosive sublimate, appears to be a compound of the two bodies, but the alkali is neutralized in this case, and it is therefore more analagous to the combination of ammonia

with the chloride of tin. When the precipitate is distilled, it gives off ammoniacal gas and also some azote, and the corrosive sublimate is converted into calomel in consequence of the action of the ammonia at high temperatures. Heated with potash, the ammonia is driven off, the chlorine is removed from the mercury, and red oxide results.

Some crystals of calomel were introduced into ammoniacal gas; they immediately blackened on the surface, and gas was absorbed. The action appeared to be exactly similar to that exerted when calomel is thrown into solution of ammonia. A black substance is produced, which though repeatedly washed in distilled water, gives off ammonia by heat, and calomel with a little mercury sublimes.

A piece of fused chloride of lead exerted but little action in a fortnight; a small quantity of gas was absorbed, and a very superficial combination had been formed.

Chloride of bismuth absorbed a small quantity of ammoniacal gas, which was again given out by heat; there was no remarkable change in appearance.

A small piece of chloride of nickel being placed in ammoniacal gas, absorbed it, and in 24 hours was converted into a bulky powder of a pale rose tint. The ammonia was separated by exposure to air, to water, or to heat.

Chloride of copper fused was powerfully acted upon by ammonia. It immediately burst open upon being placed in the gas, and absorbing great quantities fell into a blue powder. The compound placed in water was decomposed, and an ammoniacal solution of copper produced. Heated, it fused, boiled, the ammonia flew off, and the chloride remained.

The proto-chloride of iron introduced immediately after fusion into ammoniacal gas, exerted an instantaneous action; great quantities of gas were absorbed, and a very light adhesive white powder was formed. Exposed to the air, it immediately changed colour, became yellow, brown, then green, and ultimately black: this effect resulted from the presence of water in the atmosphere, and the separation of oxide by the ammonia; and the substance offers a test, if one should be wanted, for the presence of aqueous vapour. A portion of it

thrown up into a small receiver of common air over mercury, immediately changed colour, and became brown. When the powder was heated out of the contact of air it gave off ammonia, and the chloride remained.

I have not examined the action of ammonia upon the other chlorides; with some of them it would probably form neutral compounds, with other combinations similar to those described. Nearly all those mentioned are formed by the exertion of an affinity so weak that it is overcome by the attraction of water for the ammonia, and yet in one instance it is capable of giving a definite crystalline form.

The facility with which many of them afford dry ammoniacal gas at low temperatures in considerable quantities, may perhaps in some cases make them convenient sources of that substance; 19 grains of the compound with chloride of lime which had been made many days, gave 19.4 cubical inches of gas. They also offer a convenient means of ascertaining the specific gravity of ammonia, by the quantity of gas given off, and the loss of weight in the substance.

Art. IX. *Observations on the Rays which compose the Solar Spectrum.*

The third volume of the Memoirs d'Arcueil contains a paper by M. Berard on the properties of the different kinds of rays existing in solar light; the object of the Memoir is to point out by delicate experiments the relative situation and intensity of the heating rays, the rays of light and the chemical rays, and to shew the analogy which exists between them in their general physical properties.

The results contained in that part of the paper which relate to the arrangement of the three sets of rays in the prismatic spectrum, are well known here, and require no farther notice than to say that they agree nearly with the experiments of Herschel and others in this country; but the experiments

on the polarization of the rays of heat, and the chemical rays are not so well known, though they deserve every attention for their association with the brilliant discoveries made regarding the nature of light.

Having substituted a prism of calcareous spar for the one of glass used in previous experiments, M. Berard found that in each image formed by the prism, the red extremity was hotter than the violet, and this induced him to suspect that the rays of heat underwent a double refraction in the manner of the rays of light. This idea was strengthened and ultimately confirmed by further experiments, which we shall translate from his own description.

"I received all the solar rays reflected by the mirror of the heliostata, on a glass plate, at an angle such that the reflected rays were polarized, and these were again received in their turn on a second glass properly inclined. I reunited the rays reflected from this second glass by a metallic mirror, in the focus of which I had placed an air thermometer. I found that when the second glass reflected the polarised rays, the thermometer rose, and when the glass did not reflect the polarized rays, the thermometer rested stationary."

This experiment proves in an evident manner that the heat which accompanies the solar light is polarized at the same time with the light, and nearly under the same angle.

To ascertain whether the rays of heat proceeding from heated bodies were also polarized in the same manner, M. Berard proceeded as follows: "I placed in the focus of a metallic mirror 3 decimeters (about 11.8 inches) in diameter, a lighted taper, I inclined the mirror so that the parallel rays reflected from it made an angle of 19° 10′ with the horizon. I will suppose, to give clearness to the explanation, that these rays proceeded in the plane of the meridian, from south to north. I received them on a glass, 30 centimeters, (11.8 inches) long and 22 (8.7 inches) wide: this glass was disposed so that it reflected the light of the taper downwards in a perpendicular direction; and beneath it a second similar one was placed parallel to it, which reflected the rays again from the south towards the north. I received these last rays on another

metallic mirror, in the focus of which was an air thermometer, having a blackened bulb and a long tube. This mirror and the second glass were fixed together, so that they could be turned round horizontally without changing their relative position, or the inclination of the glass." The apparatus being thus disposed, it was easy, by turning the lower glass and mirror round, to ascertain that the light was constantly concentrated on the bulb of the thermometer, sufficient being reflected even at the position where the greatest quantity was absorbed by the second mirror, to render the focus evident: the taper was then removed and the whole suffer to cool.

"In the course of some minutes (M. Berard says) I placed a heated ball of copper about the size of an egg exactly in the previous position of the taper, and at the moment, the air thermometer rose about 50 centimeters (19.7 inches); then turning the second glass towards the west, the thermometer sunk more and more as it approached that point. I left it some time in that position, and the thermometer returned to within 2 centimeters of its first point. I continued to turn the second glass, and as it approached the south the fluid again rose, where having left it about a minute, it had mounted to 45 centimeters; (17.7 inches) continuing the motion of the glass, the thermometer cooled gradually until had reached the east, where remaining two minutes, it had gained its original temperature."

This experiment, which was repeated a great number of times, proves, that radiant heat reflected by a glass, at an angle of about 35°, and falling on a second glass, making the same angle with its surface, is reflected by this second plane when it is turned in two positions opposite to each other, and is not reflected in two other positions equally opposed, each being intermediate and equally distant from the two first. Radiant heat therefore, like light, may be polarized.

As to the angle at which radiant heat is most completely polarized, I have not found the means of determining it exactly: but the preceding experiment proves that it does not differ much for the same reflecting substance from that at which light is polarised.

M. Berard then substituted for the two glass reflectors, two

polished metallic surfaces, and found that in every position of the second surface, the thermometer rose nearly to the same degree. The angles of incidence were varied without any superior effect being observed towards the east than in the south; from whence it is concluded, that to heat, as with light, metallic surfaces cannot communicate the same singular properties as are given by surfaces of glass.

The rest of the section on the rays of heat, refers to experiments well known here on their absorption by opaque bodies, and their reflection and transmission by transparent substances.

The second section of the paper is employed on the chemical rays found in the solar light. Having noticed the properties of these rays in effecting certain chemical changes, and marked out the degree of effects produced by them in the different parts of the spectrum, the author says, I received the chemical rays directed in the plane of the meridian on a glass surface, at an angle of incidence of 35° 6′. The rays reflected by this first glass were received on a second at the same incidence. I found that when this was turned towards the south, the muriate of silver exposed to the reflected invisible rays was blackened in less than half an hour, whilst if turned towards the west, it was not at all discoloured in ten hours.

The chemical rays, therefore, may be polarized like the rays of light, by surfaces of glass under a certain angle, and this angle appears to be nearly the same for both kinds of rays. It is therefore to be presumed also, that the chemical rays will suffer double refraction in passing through certain diaphanous bodies.

The paper terminates by a series of conclusions drawn from the experiments described in the body of it. With the exception of those on polarization, they are so well known from the experiments of Herschel, Sir H. Englefield, Dr. Wollaston, and others, that they require no particular notice. Those relating to polarization are, that the calorific or heating rays may be polarized by glass surfaces, and that they are affected by metallic surfaces similarly to the rays of light.

Radiant heat emitted by hot bodies, is polarized by glass surfaces, when reflected at an angle equal to that at which light is polarized. Metallic surfaces have a similar action on both kinds of rays.

The chemical rays may be polarized by glass surfaces, and possess all the general physical properties of the luminous rays.

Art. X. *On the Colours of Waters.* *By* G. W. Jordan, *Esq., F. R. S.*

The colours of waters in the scenes amid which they are diffused, and of the atmosphere, and bodies existing in the atmosphere from which they are derived, have heretofore only incidentally been referred to; never, that I know of, generally stated or accounted for. Poetry has her blue and green seas, and Geography her black, white, red, and yellow seas.

The internal colour of the sea on the British coasts is green, from vegetable colouring matter brought down into it by the waters of the land. Beyond the limits of this green colour, at distances remote from land, the waters of the ocean have generally been considered as blue, from the almost constant exhibition of this colour at its surface. But neither the waters of the coast, nor of the ocean, are essentially or exclusively green or blue.

Water and sea water are in themselves perfectly transparent and colourless. The colours which they exhibit in their states of accumulation, as rivers, lakes, and seas, depend upon, and are produced by other bodies, from without and from within the waters, and are as various as those bodies and their reflections. They are not of the water; those from without are rather of the air, being reflected by the air incumbent on the surface of the water, and the water itself being altogether incapable of reflecting from and by its surface of external incidence; those from within by bodies within the waters.

Transparent bodies are of a transparency more or less perfect, of a trasparency colourless or coloured. All transparent bodies are incapable of reflecting by, or from their first surfaces, and therefore the coloured transparency of any body appears only by light which has entered into, and passed out of the body. The colours thus exhibited, are either essential or accidental, and are to be distinguished from those of prismatic refraction. Flint glass is colourless, crown glass essentially light green, yet both as prisms, exhibit all the varieties of colour in refracted light. In the opal, solution of lignum nephritium, and other semi-trasparent bodies, the colours are obviously produced by the inflections of particles diffused through the bodies, rendering them at various thicknesses variously coloured, and partially and finally opaque. The atmosphere is essentially colourless, and appears of various colours, from the inflections and reflections of bodies uncombinedly diffused throughout it. Sea water, therefore, which is in itself perfectly transparent, and at times by mixture imperfectly trasparent, exhibits *no* colours of its own. The colours reflected *from* its surface, not *by* its surface, are reflected by the incumbent air itself, perfectly or imperfectly transparent; and are the colours of all the bodies so reflected, of the sun's light or of bodies illuminated by that light, or of the sun's light changed in and by its passage through the air. The colours transmitted from within its substance, are of bodies of the mineral or vegetable kingdom carried into it by waters from the land. The flame of a candle, or any other object seen by reflection at the surface of red wine, experiences no change of colour, receives no tint from the liquor, the light seen has never entered it, and is not reflected by it, but by the air incumbent on it. Whatever light has entered and passed through or out of it, receives and carries with it the red tints of the wine. If this red may be considered essential to the wine, yet none of it is reflected at its surface of external incidence, and the case is the same with all transparent coloured bodies in air.

When light arrives at the confines of two transparent bodies,

as air and water, or water and air, it is divided into two portions varying in intensities or quantities with its different incidences respectively. When light in air arrives at the confines of air and water, the quantities of light reflected by the air, reflected from, but not by the water, vary according to the following proportions:—at 90, 80, 70, 60, 50, degrees from the reflecting surface, the quantities vary from a little below to a little above $\frac{1}{50}$ of the whole, at 40 to $\frac{1}{30}$ at 30 to $\frac{1}{15}$, at 20 to $\frac{1}{7}$, at 15 to $\frac{1}{5}$, at 10 to $\frac{1}{3}$, at 5 to $\frac{1}{2}$, at 2 to $\frac{3}{5}$, at 1 to $\frac{7}{10}$, at $\frac{1}{2}$ to $\frac{3}{4}$, and finally to the whole light. The reflection from quicksilver is about $\frac{3}{4}$ of the whole light. Accordingly, at these low incidences, the appearances produced by *the air* at the surface of the water become visibly specular, resembling those of quicksilver and metallic mirrors, as are also the total reflections of light from within at the further surfaces of glass and of other transparent bodies.

I am indebted for the foregoing estimates to the labours of those celebrated opticians, Bouguer and Boscovich; who, however, forgetting the presence of the air in their experiments, ascribe those reflections to the water alone, which are by the air; and to the quicksilver alone, those which are partly by the quicksilver and partly by the air.

Upon these varying quantities of light, and upon the changes of form in the waters, and by the waters given to the surfaces of air incumbent on them, depend all the colours exhibited at these surfaces by reflection. These colours belong not to the water, are not of its essence, are extrinsic and adventitious. Other colours there are of waters adventitious also, though observed within them, and although internal not essential.

When light in water arrives at the confines of water and air, if it be incident at an angle of inclination to the surface less than 41-30, it is totally reflected back within the water, and none passes out. If this angle be increased continually, small portions of light begin to escape into the air of intensities at first so evanescent, as not to be perceived until the incidences within the water are considerably increased. Of these, the quantities so transmitted, compared with those of

light reflected within the air, those increasing, and these diminishing, as the respective incidences are increased, come to something like an equality with them at between 60 or 70 degrees of internal incidence in water, and 50 or 60 of external transmission into air, and thus render it extremely difficult to see or to distinguish light passing out of water into air, at less angles of internal incidence within the water than between 70 and 90 from the surface, or within 20 from the perpendicular, at distances from the spectator extending to about triple the altitude of the eye above the surface of the water.

When the water is at rest, its surface is apparently specular when viewed at small angles of elevation above it, but this appearance is changed and removed when the vision is at larger angles, and any internal colours which may be in the water mingle themselves in increasing, and considerable quantities with the reflected light. But as when the angles of observation with the surface are small, these internal colours become dilute and evanescent, and finally non-apparent, the specular appearance becomes complete, and exhibits together with the images of surrounding objects, that blackness or absence of colour from the surface in other directions by which a judgment is formed of the good or bad qualities of the largest artificial specula or looking glasses. Indeed the light thus reflected, compared with that reflected from quicksilver, is, as before stated, equal and superior thereto.

These observations and estimates apply to the surfaces of water and air perfectly plane and at rest. When by surfaces thus constituted objects above and around are represented, an inverted picture of all these things is exhibited within the water, and the colours of objects are removed to their respective distances within, and are not properly or immediately referred to the surface or to the water itself. By agitations alone are the colours of reflected light brought to the confines of the surfaces of water and air, and are made to appear as colours of the water which indeed they never enter, and by which they are not in fact reflected, and from which reflected light never derives any colours whatever.

If the water be at rest and coloured within by any internal mixtures, this inverted picture is seen at considerable horizontal distances, and small angles from the surface, and is more or less bright or vivid as these respectively increase or diminish, its colours being then unmixed with any internal from the water; but as these distances decrease and angles increase, the light reflected in air diminishing, and the light transmitted from within the water increasing, this last begins to be perceived, to mix with, and to change, and finally to obscure the other with which it is mixed. When the surface of water is calm, and that of the adjacent air consequently undisturbed, every object seen by reflection as the sun or the moon is referred to its proper place within and below the water, and is single. But when undulations exist, each undulation constituting a separate reflector, the object is brought up to the surface, at distances equal to half the radices of the circle of curvature of each undulation, many images thereof are produced, and the object being sufficiently broad, the undulations of adequate size, and frequency and proximity, the different images become united; and in the case of sun or moon, form one long uninterrupted line of brilliant light, such as is very frequently observed at the surfaces of agitated waters, and of which painters have not failed to avail themselves and to introduce for splendid effect.

Upon this power of bringing objects and their colours to the surface, and upon the power which undulations further possess by change of inclination of surface, to exhibit only the most powerful of prevailing reflections, upon these principles of transmission and reflection, and their modifications by undulation of water and elevation of view, depend all the colours and variations of colours of waters.

When the sun shines in a cloudless sky at altitudes more or less considerable above the horizon, the atmosphere exhibits the following appearances:

All around the body of the sun and to considerable distances from it, a circular appearance of white light may be seen, diminishing in intensity as the distances from the sun's body

increase, in consequence of the more or less oblique reflections thereof made at the surfaces of particles floating in the atmosphere. As the white becomes diminished in intensity, it becomes more or less mixed at greater or less distances from the sun, with a blue colour produced by inflection of the sun's light in passing by some of the particles, which letting pass the rest of the light in direct passage separate the blues and giving them to be reflected in all directions by other particles of the atmosphere, exhibit that cærulean blue which the sky is known to possess. In ascending towards the zenith from the sun, this blue becomes more and more intense through the zenith, down to considerable distances on the other side of the zenith, where it begins again to be mixed more and more with white directly reflected from particles nearer the horizon, and increasing downwards in intensity, as coming from the more numerous particles existing in long trains at inclinations more and more close to the horizon, until the blues are lost therein; and all around the horizon, and to short distances above it, a breadth of white vapour seems established.

This belt of vapour rising from 8 or 10 to 15 or more degrees above the horizon all around, as the atmosphere is less or more hazy, in parts immediately below the sun is increased and mixes itself with the white light formed around him, which increasing from 7 or 8 to 15 degrees or more around the sun, and extended also in parts below him, form something like a pillar of vapour, which if the sun be not more than 30 or 40 degrees above the horizon leaves none or a very dilute blue to appear between his body and the horizon. In ascending from the horizon, however, in a direction opposite to the sun, this whiteness is changed to a blue, increasing upwards in brightness and intensity of colour, far more vivid and deep than elsewhere, and decaying on both sides towards the sun at altitudes parallel to the horizon. All these appearances are more or less intense as the atmosphere is more or less hazy, and abounds more or less in reflecting and inflecting particles. As these diminish in number, the blue becomes more intense,

putting on an appearance of dark blue, until in circumstances when the spectator is raised so high in air, as on the tops of highest mountains, where no vapours rise around and above him, the blue disappears, and one black void appears above. This appearance exhibited to persons climbing up the highest top of Mont Blanc filled them with apprehensions of falling into the dark void, and produced their hasty descent.

These are colours of the sky independant of the clouds, and are exhibited either without clouds, or through openings between the clouds, when there are any. When the sun descends nearer the horizon, and as he approaches closely thereto, the blues thus separated from his light, and dispersed, leave that which remains and is direct, yellow; and as he still descends lower, and his light passes through longer and longer tracts of particles in air, a further separation and dispersion of other portions of his light takes place, and leaves the remainder red. In these yellow and red lights of the descending sun the shadows of things exhibit successively greens and blues complementary to the yellow and red, and under these circumstances the quantity of light from the descending luminary, is so much diminished that the sun may be looked at steadily with the naked eye, and exhibits the appearance of a red globe or circle, of which, as he descends, the vertical diameter becomes diminished, the horizontal enlarged, the lower limb resembling an ellipse considerably more eccentric than the upper, changes of colour and of form, owing to the greater elevations of the light coming from the lower parts of the limb, than those coming from the upper parts in the same vertical, and to the lateral action of the particles of the atmosphere upon light, coming from other portions of the limb, by which a dilatation, extension, and distortion of parts, and apparent increase of magnitude is produced, hitherto incorrectly ascribed to ocular deception.

A green colour is seldom seen, only in small patches, and in an atmosphere filled with separate clouds, being produced by the sun's light rendered yellow by shining through some

portion of a cloud, mixing with the cærulean blue produced by other portions of his light.

Other colours exhibited in the atmosphere are those of the clouds floating within it, and consist of colours more or less white, or more or less black, and of all intermediate colours between white, gray, yellowish or gravel coloured white, dirty white, slate colour, and black, according to the circumstances in which the sun shines upon them. When the sun's light by descending close to the horizon is changed to yellow and red, and the sun shines on the lower surfaces of the clouds, in which case the reflections are very strong, the clouds assume those yellow and red colours mixed with intermediate portions of black in parts on which the sun does not shine, which produce beautiful and splendid evening and morning exhibitions of the rising and setting sun.

These are the general colours presented by the atmosphere and clouds to the waters of the earth, and from these, and other colours of other bodies occasionally exhibiting them, are derived all the colours of waters.

Although general observation has noticed only the prevailing tints of blue derived from the atmosphere to the ocean, yet at its surface may be seen, and its waters will occasionally appear to possess, all the various colours which we have shown to belong to the air, and the bodies existing in, or appearing through the air.

At a distance from land where the water is entirely unmixed with terrene and vegetable particles from the land diffused throughout its substance, and in a light cloudless day, to an eye at no considerable height above the surface, the colours are, a bright blue increasing in intensity at first at increasing distances from the spectator, then decreasing in tint until at remote distances near the horizon by obliquer reflections from the lower, and white parts of the sky near the horizon, it is changed to a white, and except in parts where, by reflection from the neighbourhood of the sun, the blue is diluted by the admixture of solar light, and changed

to the colours exhibited by those portions of the air adjacent to that luminary.

If clouds be scattered through the sky distinct and distant from each other, the blue of the waters will be changed to the colours of the clouds in places from which their masses are reflected, and if the canopy of clouds be general and black, the ocean also beneath blackens in all its parts, and assumes a dark slaty colour. If the air is full of, and covered with brilliant white clouds, so as almost entirely to exclude the aerial blue, and if the eye be near the surface of the water, that the reflections may be strong, the ocean becomes specular and metallic, and its surface puts on the appearance of quick-silver. I have occasionally at sea, by the setting sun, seen the swelling waves in the direction of the west, put on the appearance of a sea of molten gold, by the yellow light of the sun, and subsequently of a sea of blood or rather red molten metal by the change of the sun's light to red.

These are the colours proper to the ocean, they are all colours by reflection, the former seen more generally, the latter less frequently. The ocean properly possesses no internal colours, exhibits none by transmission, although occasionally, and at considerable distances from land, the greens of the land and of the sea coast penetrate into and mix with her remote waters.

The blue colours of the ocean at distances from land, and the green in the approach to, and neighbourhood of land, are so obvious as to be universally remarked. That the blues of the ocean depend upon, and are derived from the blues of the sky, or rather of the atmosphere, has been as generally observed, and to these therefore, those have properly been referred Together, however, with all the colours of the ocean, the seas of the coasts exhibit not only these greens, but occasionally also muddy and gravelly colours from inland torrents, and chalk white from the cliffs of the coast. Of these last the origin is so obvious as to admit of no question or doubt. The origin of the greens has not hitherto been so happily referred to its true causes. In the approach to land, and in

the neighbourhood of continents, the waters of the land enter the sea, more or less charged with particles, imparting their colours to the fluid; of these the largest are more immediately deposited, the smallest continue a long time to float in the fluid, and to greater distances. When the grossest earthy particles have subsided which gave their own well known colours to the waters of the land, the finer vegetable particles remain suspended, and give to the waters their green colours, changing the whole body of cærulean blues, into dirty glaucous greens, as the vegetable are more or less mixed with remaining earthy particles.

The approach to the land of England and the mouth of the English channel is known by this change of colour in the water some time before the land is seen, and this green is the colour of the sea on all our coasts, unless obscured occasionally for a short time by muddy or chalky mixtures; and to persons who have not sailed beyond its limits, has given the opinion, that such is every where the colour of the ocean, and that green is the essential colour of sea water. On the internal high lands of Barbados, from which there is a precipitate descent to its north-east coast, I had frequently observed after a night of rain, the rivulets descending from the heights, and pouring into the sea their muddy waters, which to a considerable distance within the sea marked their progress, and exhibited the dark dirty colours of agitated inland waters; whilst to distances all around from this track, and where the grosser particles carried down had subsided, an exhibition of green waters, similar to those of the shores of Europe and great continents was produced. By degrees this green disappeared or melted off into the usual blue, and the distant ocean displayed its usual colours. The muddy appearance of the land waters even in the bosom of the ocean, its change to green, and the extinction of the green in the expanse of blue waters around, led me to ascribe the exhibition of the green colours of seas, to a commixture of tints of the finest yellow particles derived from the land with the blue reflected tints of the atmosphere; but further and more general observation has

convinced me that the colours are in themselves green, and derived rather from the vegetable than the mineral kingdom of the land. They are found in all rivers and lakes, and are visible whenever the water being by subsidence cleared of its grossest muddy, but not of its green vegetable particles; the formation of waves in them, as in seas, allows the light from within the fluid to emerge from depths or thicknesses and at obliquities sufficiently great to shew the greens, or where by elevation, adequate extent of scene, and due obliquities of view are obtained.

In sailing down in the latitude in order to arrive at Barbados from the eastward, at the distance of about eighty leagues from the island, a portion of green water several leagues broad occurs, which can only be referred to some one of the South American continental rivers, perhaps the Oronoco. As from the white sands of the island of Barbados have long since been washed all particles capable of floatage, and except during land floods no waters flow from the island into the sea, the ocean there is blue to its margin, and this green water is passed through and not seen near the island. To the appearance of this green water is to be ascribed the supposed existence of land to windward of Barbados, of an island, the place of which in old maps has been laid down, and which has truly been called an imaginary island; but the green colours of seas are not derived from the shores or coasts, but from the waters of lands.

On the banks of Newfoundland the green colours at very considerable distances from land are exhibited. To the seas which cover the banks this green colour, and frequent fogs belong, and by these they are distinguished, and the approach to them ascertained. To the same cause both appearances are to be referred, the influx and commixture of coloured and of cold water from the continent of America, principally from the river of St. Lawrence and the lakes which feed it. To this influx and commixture and to the deposit of vegetable coloured materials which produce the green colours of the water, the formation of the banks themselves belongs, and the

accumulation of fishes thereon, deriving their sustenance from these same materials for which the particles of pure earths are by no means fitted. The phenomena thus happily illustrate and confirm each other. May not this floatage and deposit of vegetable materials be applied also to account for the formation of beds of coal undoubtedly composed of vegetable terrestrial matter, in a state clearly indicating such a previous condition of the materials from which they are derived, as can alone produce regular formations, such a pre-existing division of particles approaching to solution, as in their subsequent aggregation emulate crystalline arrangement, with rarely and only accidentally a few grosser fragments mixed and found therein? From beds of coal thus formed and existing below the level of the sea, one more argument is gained in favour of that system of geology, which refers so many existences on the earth to submarine formations, subsequently uncovered by the recess of the waters. Together with all the colours therefore exhibited in the distant ocean, seas near the coasts of large islands and continents exhibit also greens, dark, gravelly, and chalk white colours derived from the vegetable and mineral kingdoms of the land.

The colours of rivers, lakes, canals, and all inland basins of water, differ nothing from those of the ocean and seas; the reflected, obviously from the before mentioned properties of transparent bodies, which impart no colours to the reflections made at their first or surfaces of incidence, and because truly, the reflections of seas, rivers, and lakes are of the air incumbent on them, of the same body in all cases, and therefore are the same. These colours however, as well as those internal to land waters, are not so obvious to general observation as are those of the ocean and seas, in consequence of the generally greater expanse of these latter waters, their constant and larger undulations, and other circumstances of condition in land waters which it is proper to state.

When land waters have once become charged by torrents with various materials brought down into them, their colours are the colours of those mixtures, and only the colours of the grosser and

more copious materials are visible. These are first deposited. They are principally of the mineral kingdom. By their superior gravity they first subside, leaving the lighter vegetable particles to display their greens, at first partially and mixedly, afterwards more purely and distinctly, and subsequently more dilutedly, until by deposition of the last vegetable colouring materials in lapse of time, by rest in the reservoirs of the land, or dilution in the waters of the ocean even these disappear. These colours of inland waters are first a dark muddy hue speedily deposited, and succeeded by a colour resembling that of gravel, at first of darker, afterwards of brighter hues, mixed with yellowish and reddish tints, followed by lighter whites, allowing the greens to appear, but giving them a glaucous gray appearance; then succeed purer greens, then greens more and more dilute up to final evanescence. These internal gravelly colours so much resemble the whites of brighter clouds, that it requires nice observation, in the Thames particularly, to distinguish these colours, when derived and exhibited by reflection of the clouds, from the internal transmitted colours of land floods, or of materials again raised by the river itself from its own bed, by rushing during flood, over what had been deposited or left behind, during the quiet recess of ebb.

These internal gravelly colours so frequently occur within land to obscure the greens, that to them, to the small elevations of view, and to the want of adequate undulations, is to be ascribed the non-appearance of the relations of colour between rivers, lakes, and seas.

There is not a river, or a lake, or any basin of water however small but what, in the circumstances under which it exists, exhibits more or less to an eye duly posited and duly observant all the colours of the ocean, and of seas. I have repeatedly seen little pools of water in the open air, when ruffled by the wind, exhibiting at proper angles of observation, a blue as cærulean and intense as that of the ocean, and all the other colours of the atmosphere, and at proper depths all the varieties of internal dirty greens. In the Thames, and in the Canal in St. James's Park, at different times, from the bridge, and from differ-

ent stations around, may be seen all the colours, internal or external, of the ocean, and of the seas of the coast.

From Story's Gate, the hour of observation being generally between one and five in the afternoon, the branch of the St. James's Canal east of the bridge is seen at small angles from its surface. Its colours are occasionally of all the varieties of dark slate, lighter slate, dirty gravel, bright gravel, gravel resembling the walks of the Park, with which it may immediately be compared, whites more or less bright, blues more or less intense, and all the colours which the clouds and vapours of the atmosphere high above or close to the horizon can exhibit. Occasionally along its extent, at the same time many of these various colours appear, being reflected from various parts of the horizon, and sometimes in still weather during the spring whilst the Canal appears white by low horizontal reflection, it will exhibit patches of slate colour derived from leafless trees or its banks intercepting the colours of the sky and substituting their own. In advancing to the bridge directly from the south, the western branch frequently and generally exhibits colours differing from those of the eastern, principally darker colours from the vapours of the atmosphere in the neighbourhood of the sun, during those hours, or from clouds, whilst the eastern is generally resplendent with blue or with white. If from the bridge the water be viewed, near to the sloping bank directly under the bridge, the least depths show scarcely any colours, but as the depths increase, where there are at bottom white objects to reflect the light, the greenness becomes more and more visible, and of increasing intensity, as has been before observed of and concerning coloured and partially transparent bodies of various thicknesses.

If the Canal be looked at from the centre of the bridge along its course or length, the same greens will be exhibited of a more intense colour immediately under the spectator, of intensities diminishing as the distances of view increase, until at about distances on the water equal to triple the height of the eye above, if the water be not strongly agitated, the diminishing transmissions of light mixing with the in-

creasing reflections, are by them obscured and finally and entirely cease, and reflections alone prevail, of all their various colours of blue, or white, or slate. In passing from the Palace to the Bridge, in a calm day, the still water of the western branch being seen very obliquely, frequently presents a surface of fluid metallic appearance, sometimes resembling quicksilver, at other times of a more leaden hue.

In passing from Story's Gate to the westward, crossing the Bridge, and returning towards the Horse Guards, the eastern branch will on one side exhibit one class of colours, and on the other side another; and in the same branch, whilst proceeding parallel thereto, I have remarked successively changes of colour throughout its whole length of blues, slates, and gravels, as the sky or moving dark or white clouds gave their colours to the surface. With the wind strong and westwardly, and with considerable undulations propagated throughout its whole length, the Canal puts on the colours of the seas of the coast when viewed sufficiently near from its eastern extremity, and exhibits glaucous greens and greens more or less pure, as its waters are more or less mixed with impurities derived from the waters which flow into it, or excited by its own agitations. To observe the greens the Canal must be closely approached; at a distance, and even when approached, its remoter parts exhibit the colours of the opposite sky or clouds. For the exhibition of these colours in the Canal the brighter spring months are most favourable. In June it becomes very generally filled with water plants, which considerably interrupt these appearances, and perplex an ordinary observer.

In the Thames all these colours of the Canal may be seen under due circumstances and proper angles of observation, subject, however, to more frequent interruption by intermixture of impurities more immediately derived from the land, and more frequently and daily excited by its own flowing tides, which interfere with and obscure the greens.

With the green water of the Canal an experiment was made in the Laboratory of the Royal Institution, under the direction of Mr. Faraday, to determine whether the mixture of salt with fresh waters tended or not, to change the colour, or hasten

the deposit of vegetable matter. The first gross deposit having subsided, and been removed, an adequate quantity of salt was infused, to give the saltness of sea water; but after many days of trial, no change appeared to be produced in the green colour of the water of the Canal. To ascertain also generally the proportion of vegetable to other materials, I took the deposit of river waters, from a cistern which received them, and having dried it, I weighed a dram of the dry deposit, and having exposed it to the action of a red heat communicated to it during five minutes, found that it had lost 14 grains in weight, which taken at 12 allowing to accident the difference of loss, gives $\frac{1}{5}$ of the whole for the quantity of vegetable, mixed with other alluvial matter remaining, after a more speedy deposit of grosser materials to colour the seas of coasts, until discharged by time, and extinguished by extreme dilution in remote distances from land.

Wonderfully inaccurate is the observation of persons in general respecting these colours. They cannot but perceive the green colours of the seas of the coasts, as differing from those of other waters; but of the colours of other waters, what they really are, that they differ at different times from themselves, and how they differ, nothing is noticed. Even of water lying in present prospect, the colours are rarely observed until the attention is expressly called to and excited by naming them, and then indeed assent and admiration follow, alike establishing the truth and the novelty of the sight. I have frequently observed upon the beauty of the waters of a river in the prospect, to persons looking upon a particular scene. Then gently averting the person, I have enquired what is the colour of the water just seen? The answers have been, why—the colour of water. Is it red? No. Is it blue? No. Look round. The colour is a most brilliant blue.

Philosophers have not been more observant of these particulars. Painters alone have been practically led to observe their appropriate colours, in order that they may represent waters among other objects, and of those who correctly have painted from nature, the representations are illustrative of these principles. These principles indeed they have not possessed; but the principle of imitation and the necessity of observing has in many

cases secured them from error. With these principles, assisted by those of imitation and selection, the most brilliant exhibitions may be expected.

A painting by Rembrandt called the Windmill, belonging to W. Smith, Esq. M. P., and exhibited in the British Gallery in 1815, gave occasion to a conversation which induced the present communication.

A river winding round the base of a high bluff of land on which the mill stands, reflects the light of an atmosphere brilliantly white down to the horizon. The river of course is white, with scarcely any other mixture of colour.

I asked sportively of two gentlemen, philosophers of eminence, standing below it, and conversing in the room, what were the colours of seas, lakes, and great rivers; and limiting my question to seas, was answered by one—green, a mixture of yellow; by the other, the colours of Vandervelde's Sea Pieces, naming and referring to them in the other room. I stated, according to the foregoing principles, that I had seen seas and waters of all the prismatic colours; seas blue, green, yellow, red; seas of quicksilver, of molten gold, of blood; waters that were black, that were white; and to that I refer you, pointing to the picture, and adding, as in the story of the cameleon, "produced the Beast, and lo! 'twas —*white*."

I was further led to examine the waters of the Exhibition, as represented by several masters. In Rubens's Duke of Buckingham, belonging to the Earl of Jersey, the colour of the sea is a dirty green, very much resembling the green water seen immediately from below the bridge of the Canal, not so dilute as the seas of the coast. Of Vandervelde the waters may be said to have no natural colours at all, scarcely more than the lights and shades of engravings. Cuyp's colours are such as a day of sunshine thickly overspread with masses of white and dark clouds gives to waters. This gravelly colour, which may be either external by reflection, or internal from turbid waters, Cuyp gives to his waters of Dort, with no green; and little blue.

I have stated that the colours exhibited at the surfaces of water are reflected by the air incumbent on the water,

and not by the water, which is incapable of reflecting light from or by its surface of external incidence. The general and philosophic misconceptions on this point require here to be observed upon. The existence of any power in bodies to repel light, has been formally and completely disproved by observations on the inflections of light. Light is attracted by the parts of all bodies. This is sometimes admitted and sometimes denied by observers, even to the same bodies in various circumstances. If light pass out of glass into air, and particularly when the reflection is total, this is ascribed to the glass; if partially, the reflection is assigned to the glass, the refraction to the air, by attractions of both. Let the light pass out of air into glass, both the reflection and refraction are ascribed to the glass, and in similar circumstances to water. This reasoning ascribes to the glass in this latter case, powers opposite to and inconsistent with those of the former case, and deprives the air of all the power in the first instance assigned to it. The air not being seen, nor so obvious as the glass, seems in this case forgotten or disregarded, and such is the state of general opinion on this subject.

At the confines of two adjacent transparent bodies, one of which at least must be fluid, spaces naturally exist different from the pores of either, in consequence of the attractions of the particles of both being different, as well as stronger for themselves than for each other; otherwise one would be dissolved by the other, as chemists know. In these spaces the bodies by their respective attractions for light, divide whatever portion thereof arrives therein into two parts, one passing into and said to be refracted by the further; the other returning into, and said to be reflected by the nearer body. The nearer body can alone reflect, the further alone refract; and these are the cases of air and water in these observations. In these same spaces, and by the same attractions in other circumstances, the emission of light is produced. That these forces exist, and that by them the phenomena of the emission, reflection, and refraction of light are produced, may be proved

by arguments of the same nature and force, as those which prove the moon to be retained in her orbit by the force of gravity, by proofs establishing the existence, adequacy, and quantity, and therefore necessary agency of these forces.

Art. XII. *On the original Composition of the Statues of Niobe and her Children.* *By* Robert Cockerell, *Esq.*

The statues composing the groupe of Niobe and her Children has long been considered amongst the first specimens of art. If all the figures were not executed by the same hand, their style and composition leave little doubt that they were the conception of one mind: they are obviously designed to form a whole, but placed without order or design as they were, and still remain, the figures appear without connection, and to act rather in opposition to each other, than as forming a combined action or connected groupe, and they can only be regarded in their present position as single figures, without reference to their combined effect. None of the antiquarians who have noticed these statues, (including Winckelman, Fabroni, Mengs, Goethe, and Zannoni), have attempted to solve this difficulty. Mr. R. Cockerell, whose travels we noticed in a former Number, about two years since published in Italy a plate explanatory of his ideas respecting the composition of these statues, which represents, as he maintains, the fable of Niobe and her family. This plate was accompanied by a short explanation of Mr. Cockerell's reasons in support of his opinions respecting the original composition of these statues. Although Mr. Cockerell's merits seem to have but tardily reached his own country, neither his talents or his knowledge have remained unnoticed on the continent.

These statues are supposed by Mr. Cockerell to have been originally designed for the tympanum of a pediment of a temple, the elevation and measurement of which has been

given by him in his plate, a reduced outline of which we have, by his permission, given in this Number. We shall present our readers with nearly the whole of Mr. Cockerell's observations on the subject.

The celebrated statues representing the fable of Niobe, have never been so described as to give a satisfactory idea of their relative situations, and the composition of the groupe for which they were unquestionably designed.

Montfaucon (Vol. I. p. 107,) has given a plate engraved by Perier representing these statues, ranged in a circle around the mother, as they were then placed in the villa Medicis at Rome; but this disposition, which was a mere conjecture, and entirely unsupported by the authority of the ancients, or any one single example, is entirely disproved by examination of the statues themselves, and of their different attitudes, which demonstrate that they were originally intended for only one point of view,* as will be seen from the note below, which describes the different sides of the statues.

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* The statue No. 1, was designed solely for the position assigned in the group, for if viewed in the front, the right leg is rendered invisible by the rock which sustains it; besides which, the chest is without relief and ill executed. No. 2, on the opposite side the left leg is entirely concealed behind the rock, and the drapery suspended from the arm is but imperfectly made out. The back part of the statue No. 3 is also negligently executed and badly designed, without relief or execution. The hinder parts of No. 4, 5, 6, 7, and 8, although completely made out, are not better executed than the preceding numbers. No. 9, on the front side, the contour of the body, the hair, and the ear on the right side, are carefully finished; on the left they are merely sketched. The statue No. 10, is unfinished on the opposite side, and the right leg is concealed by a trunk of a tree. No. 11 and 12 are also left unfinished on the opposite side. No. 13: with respect to this figure, the point of view given is evidently the only possible one it could have been designed for, as the right leg is entirely wanting; and it is evident that Nos. 6, 7, and 9, were designed for a situation above the level of the eye, the different parts being more or less finished, according to the effect to be produced when seen from below.

That it was customary with the Greeks to adorn the pediments of their temples with groups of statues is sufficiently proved by the remains of the temple of Minerva at Athens, called the Parthenon, by the discovery of those of the temple of Jupiter Panhellenius in the island of Egina, and of many other temples on which may still be traced the remains of similar ornaments, as for instance, the temple of Theseus. Pausanias also has accurately described the frontispiece of the temple of Jupiter at Olympus, Diodorus that of Jupiter Olympius at Agrigentum, and many other instances might be cited.

The relative dimensions of these statues, the gradual diminution in their height, their action, which is a general inclination towards the central point, and the simplicity and harmony of composition, resulting from their arrangement, all tend to prove that these statues were designed for the tympanum of a temple.

The passage in Pliny,* as it was written by one who may be supposed not to be conversant with technical terms, impugns what has been before laid down, but it is altogether unnecessary to cite it, as these statues may have been arranged at Rome in a manner totally different from that in which they were placed in their original situation from whence they were brought.

These statues, since their discovery in 1583, have heen considered by the antiquarians as an interesting subject of discussion, both by reason of their perfect preservation, and of their extraordinary excellence as works of art; and it is singular that the authority of Ovid should have been preferred by them to that of other authors, although no circumstance of his description coincides with these statues, with the exception of the wrestlers, which are however admitted to form no

* Hist. Nat. XXXVI. ch. 9. Par hæsitatio est, in templo Apollinis Sosiani Nioben cum liberis morientem Scopas an Praxiteles fuerit.

part of the present group, although found at the same time and in the same spot. It should also be remembered that they were executed many centuries before Ovid's time, and doubtless, Scopas and Praxiteles would have preferred the authority of Homer, who gives Niobe only twelve children. In the excavation, with the exception of the two wrestlers, the statues of twelve children only were found, and these were in good preservation;* fragments of the thirteenth and fourteenth would without doubt have been discovered had they existed; consequently it seems nearly certain, that the total number of the statues, including the mother and the statue No. 10, did not exceed fourteen.

In Mr. Cockerell's design of the composition or restoration only the fourteen figures which were found together in the same excavation have been introduced.

Their disposition is regulated by their heights, which have been accurately measured, and by the form of the tympanum; and independently of this, it is frequently obvious by the relative connection of the different statues.

From this arrangement a beautiful composition is produced, in which is represented the fable of Niobe. The principles of elegance are completely observed in the group; six figures are symmetrically disposed on each side, presenting a variety of action and expression which produce an admirable contrast, and the composition may be considered as complete.

M. Schlegel, in a paper which he wrote on the subject of Mr. Cockerell's design, expresses his entire assent to the general views of Mr. Cockerell respecting these statues, but questions the place assigned by him to some of them, his assertion that we are in possession of the whole number of statues which formed the original composition; and lastly, the originality of the whole; that is, whether these

* Mr. Schlegel observes that this is somewhat inaccurate, as several of the statues required considerable restoration, and that some fragments had been collected together.

statues are the production of Scopas, or Praxiteles, or merely a copy. In a remark on the difference in size between the mother and the children, Mr. Schlegel observes, that although it is contrary to the principles of art to employ two different scales for the dimensions of figures in the same compositin, that the same objection arises with respect to the Laocoon and his children, and the Colossal figures on the Monte Cavallo and the horses; but that these incorrectnesses were not accidental, but designed for the production of beauty and a grand effect.

In observing on the different statues, Mr. Schlegel suspects that No. 6 does not belong to the group, considering that statue not to partake of the light and youthful figure of the rest of the children. The statue No. 10, which Fabroni took for Amphion in the dress of a hunter, is also suspected by him. No. 11 is positively rejected as not belonging to the composition, the hair being arranged differently from the rest, and the head is without that general resemblance which appears to pervade the rest, and the figure does not seem to partake of the general action of the group.

Mr. Schlegel closes his paper on the subject with the hope that Mr. Cockerell will speedily give to the public those designs and observations respecting ancient Greece which have so long occupied his attention. In this wish we very heartily concur; and from what we have seen, can safely assert, that notwithstanding the ingenuity and knowledge which have been displayed by Mr. Cockerell, in the dissertation on these celebrated statues, his merits can in no wise be fairly estimated by the work we have noticed.

Art. XIII. *Select* **Orchideæ** *from the Cape of Good Hope. Continued from page 206 of the Fourth Volume of this Journal.*

Of Disa *porrecta*, Disperis *secunda*, and Disperis *capensis*, represented in Plate I. of this Number.

Three interesting Orchideous species are added in this place to the three of the last fasciculus. The drawings of these have been derived from the same source as those of the others, and we shall refer to the article concerning them for the character of the order, and for that of the genus Disa.

Plate I. *fig*. 1. Disa porrecta.

Disa *porrecta*, casque obtuse, conical at the back, spur subulate outstretched; interior segments with two teeth; label oblong undulated; spike ovate many flowered.

Disa porrecta. *Swartz act. holm*. 1800. 211. *Id. in Schrader's neues journal*, 1. 27. *Willd. sp. pl*. 4. 47.

A species first recorded by Swartz. We are not aware that it has been even introduced into any European garden. There are indigenous samples of it in the Banksian Herbarium, which were collected by Masson.

Plate I. *fig*. 2. Disperis capensis.

Disperis. Corolla ringent, 5-parted: three of the *segments exterior*, upper one of these upright, vaulted, and forming with the two *interior lateral ones*, which are contiguous to it, either an upright or a depressed and incumbent casque. *Two exterior lateral ones* pointing forwards, and horizontally divergent, each with a short obtuse pouch or spur that projects downwards: *label* upright from the base of the column, tapered at the lower part, grown to the parts of fructification, bent back at the top underneath the casque. *Column* very short, oblong-cylindrical. *Anther* grown to the column at the summit, either upright or reclined, oblong, two-

celled; concealed by a *veil* or curtain from each side of the edge of which a small cartilaginous spirally recurved strip is projected towards the front. *Pollen-masses*, the same as in Orchis, with their footstalks adhering to the two strips of the veil. *Stigma* in front, near to the anther. *Capsule* like most others in the order.

Obs. The name is compounded of *δις*, *bis*, and *πηρα*, a pouch, the two exterior lateral segments of the corolla having each a small obtuse pouch or spur. The genus comes very near to Pterygodium, but differs in having these pouches, as well as by the insertion of the label, besides having another shaped anther, and a differently situated stigma.

Disa *capensis*, stem two-leaved, one flowered; leaves lanceolate.

Disperis capensis. *Swartz act. holm.* 1800. 220. *Id. in Schrader's neues journal.* 1. 40. *Willd. sp. pl.* 4. 59.

Arethusa capensis. *Linn. suppl.* 405. *Thunb. prod.* 3.

Said to grow on the Table Mountain. The genus is perhaps one of the most singular of the order. We know of no species of it that has been introduced into any European garden; or that has been represented by a published figure. Specimens of the present are preserved in the Banksian Herbarium.

Plate I, *fig.* 3. Disperis secunda.

Disperis *secunda*, stem two-leaved, many flowered, leaves linear: flowers pointing one way.

Disperis secunda. *Swartz act. holm.* 1800. 220. *Id. in Schrader's neues journal.* 1. 40. *Willd, sp. pl.* 4. 60.

Arethusa secunda. *Thunb. prod.* 3.

Ophrys circumflexa. *Lin. sp. pl. ed.* 2. 2. 1344. *Amœn. acad.* 6, *afr.* 95.

The Banksian Herbarium contains indigenous samples of the species, collected by Masson.

enter it. After standing for fourteen hours exposed to the action of the external air,* through the tube, its liquidity was unimpaired. The glass tube was then withdrawn, and next the cork, without any change ensuing; when finally, on agitation, it solidified

5th. A phial was nearly filled with a similar solution of sulphate, on the surface of which was placed a little olive oil. It cooled without crystallizing. When smartly agitated, it became solid with the usual phenomenon of the crystals shooting from the top downwards. This phial had been first placed on a vibrating glass plate, without effect. This experiment was repeated with a like result, though the phial stood two days.

6th. A corked phial full of the hot solution was tied down to the plate of the air-pump, so that the cork could be drawn *in vacuo* by a sliding steel rod and hooked extremity. When the cork was pulled, no change ensued; but agitation congealed the mass.

7th. The corked phial was cooled in a horizontal position; on inverting it quickly, the liquid struck against the glass, as in the water hammer. By brisk agitation in the inverted position, congelation began, first below, and ascended to the top of the liquid. This experiment was repeated, with the same result. No particle of air was left in the phial; a cork of the best quality being pressed on the surface of the liquid, and forced in as the liquid contracted its volume, on immersing the phial into a basin of cool water.

8th. A glass tube twelve inches long, and one inch in diameter, furnished with a brass cap and stop cock at one end, and a tight cork at the other, was filled with the hot solution. When it was cold, each end was opened, and the crystallization began instantly at the two extremities, and proceeded to the middle.

9th. Same tube filled and cooled, with a platina wire passing through the cork. On applying to each end, the opposite

* Temperature of the apartment about 40° Fahr.

electric influences of a voltaic battery of 50 pairs of 4-inch plates, the pearly crystallization commenced at the negative end, and proceeded slowly to the positive, at which no symptom of spontaneous congelation could be perceived. The platina wire was positive, and evolved oxygen pretty copiously.

10th. A large egg-shaped vessel, holding about two pints, and terminated at each end with cylindrical apertures of one inch diameter, was filled with the hot saturated solution. Through the cork of each end was passed a platina wire. The vessel, after having been cooled in a bason of cold water to the temperature of 42°, was placed in a horizontal position, and the solution was subjected to the action of a battery of 60 pairs of 4-inch plates. From the oppositely electrified wires, hydrogen and oxygen gases were copiously evolved. The quantity of gas was much more abundant than I ever observed it from pure water with the same voltaic power. Hence, a saline solution affords a better medium for the popular exhibition of this fundamental electro-chemical fact, than water alone. After a few seconds, the pearly lustre appeared at the negative end of the vessel, and the crystallization proceeded slowly and steadily towards the positive end, the plane of demarcation between the congealing and liquid part being perfectly smooth and vertical. No tendency to solidification was observed at the positive end, though gas freely flowed from its platina wire during the whole time that the process of crystallization was advancing from the one extremity to the other. This interval was about 15 seconds.

10th. The above experiment was repeated with a small cylinder with tubular extremities. The negative wire projected internally only to one half the length of the positive wire, in order to see whether it was merely the greater quantity of hydrogen evolved, or some difference in the electrical properties that determined the crystallization at the negative pole. Here again, as before, the pearly appearance commenced at the negative extremity, and proceeded beautifully to the positive.

It was impossible now to doubt, that there existed some relation between negative or resinous electricity, and saline crystallization.

11th. Two glass capsules were then taken. Into each an equal quantity of a tepid solution of pure nitre was put. They were placed along side of each other, and the liquids were connected by a slip of clean filtering paper, moistened with pure water. The power of 60 pairs in moderate action was applied, through the medium of a platina wire dipped into the centre of each solution. In a short time small needles were seen collecting, and attaching themselves around the negative platina wire, which soon increased so as to float through the whole liquid. After a much greater interval a few crystals were perceived forming on the margin of the liquid in the positively electrified capsule, but none near the immersed platina wire. In equal times the quantity of crystals in the negative capsule was quadruple of that in the positive capsule. There was found in the former a very slight excess of alkali, and in the latter of acid, but such as in ordinary circumstances has no influence on the formation of crystals.

12th. A tin flask was filled with the same hot solution, and having its mouth secured with a slip of ox-bladder, it was suffered to cool. It was then placed on the top of a delicate condensing electroscope; and the bladder being pierced with a needle insulated at the end of a glass rod, no divergence of the gold leaves could be observed, even when both the large and small condensing plates had been folded back. I am not certain that in this case the liquid had remained uncrystallized till the instant of piercing the bladder. I shall repeat and vary the experiment, and from the elevation of temperature accompanying the solidification, I shall be able to ascertain whether the experiment has been successfully conducted, and whether any general inference can be drawn from it.

I think it probable from the above detail, that negative electricity may be found a useful agent in promoting the crystallization of saline matter, and may perhaps be employed by Nature in her crystalline formations.

The effect of mechanical disturbance in determining saline crystallization, is illustrated by the symmetrical disposition of particles of dust and iron by electricity and magnetism. Strew these upon a plane, and present magnetic and electric forces at a certain distance from it; no effect will be produced. Communicate to the plane a vibratory movement; the particles at the instant of being liberated from the friction of the surface, will arrange themselves according to the laws of their respective magnetic or electric attractions. The water of solution in counteracting solidity, not only removes the particles to distances beyond the sphere of mutual attraction, but probably also inverts their attracting poles. Hence, when they are again brought within the attracting limit, by abstracting the water or the repulsive caloric, some additional force is necessary to revert this liquid arrangement of the poles. It is thus that a crystal, brought into contact with the surface of the solution, may be conceived to act.

Experiments 3d, 4th, and 5th, seem to prove that neither the chemical properties of the atmosphere, nor its pressure, have any influence on the crystallization.

ART. XV. *Biographical Notice of the late Mr.* CRANCH.

In the introduction to the Narrative of the Expedition to the Congo, biographical notices are given of several of the unfortunate persons who fell victims to the dreadful fever which terminated the hopes of the party: That of Mr. Cranch we think peculiarly interesting, and we present it to our readers.

MR. CRANCH was one of those extraordinary self-taught characters, to whom particular branches of Science are sometimes more indebted, than to the labours of those who have had the advantage of a regular education. He was born at Exeter in the year 1785, of humble, but respectable parents; at eight years of age he had the misfortune to lose his father;

and as the circumstances in which his mother was left, did not enable her to provide for all her children, John, the subject of the present memoir, was taken charge of by an uncle living at Kingsbridge. The main object in life, and which was nearest to the heart of his relation, was the accumulation of wealth; and his extreme penury denied to his nephew, almost the benefit of a common education. The miserable guinea which procured for him a year's instruction, was wrenched from him with so much grudging, and in a manner so unkind, as to be then severely felt, and never afterwards forgotten.

At the age of fourteen, this provident relation first put him out as an apprentice, to learn "the art and mystery of shoe making," a line of life which, from its peculiar monotony, seems by no means unfriendly, as experience has shewn, to the progress of intellectual acquirement. The strength of mind for which young Cranch had been distinguished from his childhood was now constantly struggling with the adverse circumstances of his situation, but every moment which could be stolen from his daily labour, was devoted to the few books which he had found means to collect; the study of natural history was that in which he mostly delighted; and, even at this early period of his life, he was able to draw up correct descriptions of all the insects he could procure in the neighbourhood of Kingsbridge. Without other assistance than books, he had acquired sufficient knowledge of Latin and French, to enable him to understand thoroughly those languages, when made use of by zoological writers, and to employ them himself, in describing objects of natural history. He had acquired also a general knowledge of astronomy. But, while thus eagerly endeavouring to grasp at science, every thing tended to depress, and nothing to encourage him. However, he had the fortitude to persevere; and continued, in spite of every obstacle, silently and sedulously, unnoticed and unknown, to nourish his ruling passion, the love of knowledge.

At the expiration of his apprenticeship, he went up to

London, with the professed view of improvement in the art of shoemaking, but in reality with higher objects and better hopes, though he hardly ventured to own them to himself. The manners and morals of his fellow workmen were ill suited to his feelings and pursuits, and served only to increase his dislike for the employment to which he had been doomed. But it was some consolation to reflect that he was in the great mart of human knowledge, and though unfriended, and a stranger, he found that information flowed in upon him on every side. His mind was filled, but not satisfied; every museum, auction room, and book stall, every object to which his attention was called he visited with a rapid and unsatiable curiosity, gleaning information wherever it was to be had, and treasuring it up with systematic care. His account of what he observed in the capital is said to exhibit an obvious and striking proof of an inquisitive, diligent, and discerning mind. A person of this stamp could not long remain in London without meeting with kindred spirits. One of these associates, speaking of Cranch, observes, " our conversations and philosophic rambles near London, have often called forth such observations and disquisitions from him on the various qualities, attributes, combinations, provisions and arrangements of nature, as marked vast comprehension, as well as the most delicate subtilties of discrimination in an intellect, which seemed indeed to be calculated to grasp magnitude and minutiæ with equal address, and which could at onec surprise, delight, and instruct."

After a residence of some time in London, he returned to the haunts of his childhood; but it was soon discovered how little chance the " boot maker from London" had of eclipsing even his humble rivals who had never lost sight of the smoke of their native hamlet; but he had no alternative, he must eat to live, and work at his trade to be able to eat; his labour however produced him little more than a bare subsistence, and every moment that he could venture to take from it, was dedicated to his favourite pursuit.

Shortly, however, his domestic circumstances were favourably improved by marriage. His workshop was now consigned wholly to his journeymen, while he was sedulously and successfully collecting objects of natural history. No difficulties or dangers impeded his researches; he climbed the most rugged precipices; he was frequently lowered down by the peasants from the summits of the tallest cliffs; he waded through rapid streams; he explored the beds of the muddiest rivers; he sought the deepest recesses. He frequently wandered for whole weeks from home, and often ventured out to sea for several days together, entirely alone, in the smallest skiffs of the fishermen. No inclemency of weather; no vicissitudes of "storms and sunshine," ever prevented his fatiguing pursuits; the discovery of a new insect amply repaid the most painful exertions. Several papers in the "Weekly Entertainer," a little work which accompanies one of the most popular of the western newspapers, were written by him; and by these, and his collection of subjects in natural history, he gradually became better known, and his talents duly appreciated by the most able naturalists. Of this the following extract of a letter to the editor, from Dr. Leach, of the British Museum, bears ample and honourable testimony.

"In 1814, Mr. Montagu and myself, together with Mr. C. Prideaux, visited Mr. Cranch, for the purpose of seeing his Museum. We were all astonished at the magnitude of his collection of shells, crustacea, insects, birds, &c. collected entirely by himself, and still more so with the accuracy of their classification and with the remarks made by this self-educated and zealous individual. He conversed on all subjects connected with natural history, with modesty, but at the same time, with that confidence which is the result of knowledge. Quite delighted with having made his acquaintance, I left him with a resolution to cultivate a correspondence with him on the subject of our favourite pursuit. On the following morning, I received a note from him, offering me any specimens that might be wanting and that he could supply, to my collection.

"Soon after this meeting, I was appointed to the British

Museum, when Mr. Cranch applied to me to endeavour to obtain for him some situation in that institution, which would enable him to cultivate the study of natural history on a more extended scale; but as no vacancy existed, and as I found his demands for employment come within the limits of my pocket, I proposed that he should undertake to investigate the coasts of Devon and Cornwall for marine productions; and eventually to make a tour of Great Britain, with the same view; at the same time I promised to recommend him to the first situation that might occur, to enable him to obtain the object of his ambition.

"On receiving my letter he immediately discharged his journeymen, and converted his manufactory of boots and shoes into apartments for the reception and preservation of such objects of natural history as his daily exertions might procure. He kept up a continual communication with the fishermen of Plymouth, and constantly received from them baskets filled with the rubbish they dregged from the bottom of the sea; and this he examined with diligence and attention, preserving all the new objects that he discovered, and making descriptions of them. He visited occasionally, the Brixham, Plymouth, and Falmouth fishermen, and made excursions with them. He very often left Kingsbridge in an open boat, and remained absent for a long time together, during which, he dregged when the tide was full, and examined the shores when it was out. At night he slept in his boat, which he drew on shore; and when the weather was too stormy for marine excursions, he would leave his boat and proceed to examine the country and woods for insects, birds, &c. The remarks with which he accompanied the infinity of new objects which he discovered, are invaluable; many of them have been and the rest shall be hereafter made public."

In this way was Mr. Cranch employed for the collection of natural history in the British Museum, at the time when the expedition to the Congo was planned: for such an expedition, a person of this description was invaluable, and Dr. Leach recommended him to Sir Joseph Banks, as one in every way fitted for the undertaking. On his part, an appointment so suited to his pursuits and so flattering to his hopes, was the height of his

ambition, and he at once accepted it, though not without some painful struggles to his feelings. It seems he had a sort of presentiment that he should never return, and that the expectation of such an event became weaker and weaker, as his country faded from his view. His conduct, however, during the voyage out, does not appear to have been influenced by this feeling; nor were his exertions at all relaxed by an occasional lowness of spirits, which was, perhaps, partly constitutional, and owing partly to the gloomy view taken of Christianity by that sect denominated Methodists, of which, it seems, he was a member. He is represented, however, by his friends, as a sincere Christian, an affectionate parent, and a kind friend.

Mr. Cranch was taken ill on the 23rd of August, on the march between the banza or town of Cooloo and the banza Inga, and was carried back on the shoulders of the natives to Cooloo, and from thence in a hammock to the place of embarkation below the rapids; but it was the tenth day before he reached the ship in a canoe. The symptoms, by the surgeon's report, were an extreme languor and general exhaustion; a restlessness and anxiety, approaching at times to delirium, but he had no pain, except an uneasy sensation throughout the abdomen; the countenance became of a dirty yellow colour, the pulse was 108°, and very small. The next day he was much worse, and on the third day the whole body became yellow: the countenance assumed a deadly aspect, the pulse at the wrist imperceptible, and in the evening he expired, " after uttering," says Mr. Fitzmaurice, " a devout prayer for the welfare of his family, and with the name of his wife quivering on his lips. He was of that order of dissenters," he adds, " who are called Methodists, and if I may judge from external appearances, he was an affectionate husband and father, a sincere friend, a pious, honest, and good man." He died in the 31st year of his age, and was buried at Embomma by permission of the King in his own burial ground, where he was laid with military honours by the side of his fellow-traveller, Mr. Tudor, who had been interred with the like ceremony, a few days before.

Art. XVI. *Miscellanea.*

I. Mechanical Science.

§ 1. Astronomy, Optics, Pneumatics, &c.

1. *New Comet.*

A new comet was discovered at Marseilles on the night of the 26th of December last, by M. Pons, in the constellation of the Swan, near the northern wing. It had a nebulous appearance. Its light was extremely feeble and its figure indeterminate. It had neither nucleus nor tail. It was seen again on the 29th of the same month, in the evening, but only for a few minutes, in consequence of clouds. Its situation was then about two degrees south of its first observed position. Its light was more bright, and its apparent size increased. A small nucleus could then also be distinguished.

It was seen again on the morning of February 14th, and was still in the constellation of the Swan, but farther south.

The same comet has been observed at Augsbourg on the 2nd of this month. It was found near the star *i* of the fourth magnitude, on the outside of the wing of the Swan, and above the constellation of the Fox. It is considerably enlarged, and its nucleus is now very distinct.

2. *New Observatory at Cambridge.*

It is proposed to build an observatory within the precincts of Cambridge University, the expense of which is estimated at about 10,000*l*. A grace will be proposed to the Senate for a donation of 5,000*l*. from the University chest, and a subscription opened for raising the remainder of the sum. Application is to be made to Government to appoint an observer and an assistant, with adequate salaries.

3. *Supposed Transit of a Comet.*

Mr. Capel Loft, in a Letter to the Editor of the Monthly Magazine, describes a body passing over the sun's disc, which he supposes may have been a comet.

" I saw it about 11 A. M. (on the 6th of Jan.) with my own

reflector, with a power of about 80; with an excellent Cassegrain reflector made by Crickmore of this town, with about 260; and with a reflector of Mr. Acton's, with about 170.

"It appeared, when I first saw it, somewhat about one third from the eastern limb; subelliptic, small, uniformly opaque.

"About 2½ hours P. M. it appeared to Mr. Acton considerably advanced, and a little west of the sun's centre, and I think it appeared then 6 or 8 seconds in diameter. I had been able to see no spot on the 4th, nor again on the 8th; and even on the 6th Mr. Crickmore could not see it a little before sunset, though the telescope already mentioned gave him every advantage.

"Its apparent path while visible seemed to make a small angle with the sun's equator. Its state of motion seemed inconsistent with that of the solar rotation, and both in figure, density, and regularity of path, it seemed utterly unlike floating scoria. In short, its progress over the sun's disc seems to have exceeded that of Venus in transit.

There are two instances, if not three, of comets seen in transit, and this phenomenon seems to have been one. I wish it may have been seen elsewhere."

Ipswich, Jan. 10.

4. *New Photometer.*

Mr. Horner of Zurich has invented a photometer which, for its simplicity of construction and facility of use, deserves to be made known. An account of it has been published in the Bibliothèque Universelle, from which this extract is made. It consists of a pasteboard tube an inch and half in diameter, and four inches long. A flat ring of much larger diameter surrounds it a short distance from one end, and an opening is made in the ring, by which slides can be made to traverse through and across the tube. The opposite end of the tube is cut into a form which will fit round the eye and exclude extraneous light when the instrument is used, and within it is a convex lens of two inches focus, which renders the diaphragms that are passed through the ring perfectly distinct.

The scale of the instrument is constructed on the same principle with that described by M. Lampadius, and consists of

a number of similar diaphanous discs, which are added together at the outer end of the tube until they intercept all light, and the number necessary for this purpose indicates the intensity. The units or degrees of M. Horner's scale are discs of very fine, thin China paper, covered with oil varnish on each surface. A thin plate of metal, wood, or other substance, capable of being passed through the orifice in the ring is perforated with 10 round holes, the first of these is left open, and the others are covered by the discs of paper from 1 to 9 progressively, each being properly numbered. These supply the units in observation, and the tens are made by putting together 10, 20, or 30 discs, pressing them close and connecting them into one mass by an edge of very fine paper pasted on.

In using the instrument, the eye being applied to its proper end, the other is directed towards the light to be measured, and then one or more bundles of the tens are introduced, acccording as the light is more or less brilliant, at the object end of the tube, and pressed together by a small ring or short tube introduced after them; then, by passing the slider with the units across the tube till the light is entirely excluded, the number of discs necessary is ascertained, and the light estimated accordingly.

To make the instrument more sensible, it is proposed that an object glass of some inches focus be fixed at the outer end of the instrument.

The fixed point of the photometer has been made after M. Lampadius, the light of phosphorus when burning in oxygen gas, and if any alteration occur in the state of the discs, it is rectified by comparison with this point.

The following are some observations made with this instrument:

Light of the sun at an elevation of 30°, sky perfectly clear - - - -	75 degrees.
Ditto, sky white - - - - .	70
Light of a blue sky at an elevation of 45°	56
——— zenith - - - -	49
Light of a cloudy sky - - -	53

Light of a full moon - - -	34 degrees.
——— moon 5 days old - -	20
——— from snow enlightened by the sun -	57
——— from snow in the shade -	47
——— starry sky, (14 March, 1817) -	7
——— sky clear of stars, (14 March, 1817)	4.5
——— planet Venus at an elevation of 30° (5 April, 1817) - - -	9
——— constellation of Orion, (14 March, 1817)	7
——— of a common candle 2 feet distant -	48

5. *New Barometer.*

A new barometer has lately been invented by Mr. Adie of Dumfries. It is described as being more portable than the common barometer, and less liable to accident. The moveable column is oil enclosing in a tube a portion of nitrogen, which changes its bulk according to the density of the atmosphere. This is something like the common air thermometer.

6. *New Musical Instrument,*

M. Marstrand of Copenhagen, celebrated for his mechanical inventions, is said to have invented a new musical instrument called the *Harpinella*. It is in the form of a lyre, is smaller than the common guitar, and yet equal in tone to the harp. By a very simple piece of mechanism, the semitones are made with the same facility and precision as on the pedal harp.

7. *M. de Lalande's Medal.*

The gold medal founded by the late M. de Lalande has been awarded by the Institute and Royal Academy of Sciences at Paris, to Mr. Pond the Astronomer Royal, at Greenwich, for his interesting and important researches on the annual parallax of the fixed stars.

§ 2. ARCHITECTURE, NAVIGATION, THE ARTS, &c.

1. *Plymouth Breakwater.*

The breakwater at Plymouth has withstood the late gales in an almost unexpected manner; the only thing which gave way was a crane, that could be replaced in a few hours.

At the commencement of the winter a few large stones were placed by themselves on the top or finished part of the breakwater, to ascertain how far they would withstand the

winter gales, they stood all but that which occurred the begining of this month; it moved them, and they were found lying on the north slope. There were three of them, one of nine tons and the other two of five tons each; they are to be replaced for further trial.

2. *Moveable Axletree.*

Mr. Ackermann of the Strand has lately introduced a considerable alteration into the axletree of carriages. The improvement, it is said, will allow the carriage to be built 18 inches shorter; the body to be hung lower, and the fore wheels to be made larger. The vehicle will turn in much less space than carriages of the common construction, and is more difficult to overset. Several coachmakers are constructing carriages upon this new plan.

3. *New Harpoon.*

A new harpoon has been invented by Mr. Robert Garbutt, of Kingston upon Hull, for the Greeland fishery; calculated to secure the whale in the event of the shank of the instrument breaking. The improvement consists in placing a kind of preventer made fast to the eye of the foregager, which passing along the shank of the harpoon, is attached to the thick part of it in such a manner as neither to lessen its strength nor impede its entrance when the fish is struck.

4. *Harpoon Guns.*

Some of the Leith whale ships are furnished with harpoon guns for this year's service. The gun is mounted on the bow of the boat, and the harpoon with the line attached is fired out of it, and will strike at the point blank distance of 20 or 30 fathoms; by which means a fish may be struck when there is no chance of reaching it by throwing the dart with the hand. They have been used by the Hull vessels for several years.

5. *Nautical Instrument.*

Among other ingenious inventions submitted to the Board of Longitude, one countenanced by the Board and recommended to the Lords of the Admiratly for immediate trial, is likely to facilitate the object intended in exploring the polar regions. The merit of this invention is, that it works horizontally and

vertically, assuming the magnetic meridian by its own action. The inventor is Mr. Lockwood of the navy.

6. Machine to Sweep Chimnies.

Mr. C. Carr, of Paddington, has constructed a machine to sweep chimnies, which appears to possess great advantages. It is complete of itself, requiring no chain, pulley, or other appendage in the chimney, and will sweep very clean as well in horizontal as perpendicular flues. If the flue be angular, having one or more bends, the person who uses it can ascertain the direction in which the angle goes off, and can turn the head of the instrument the proper way. There is a means also of ascertaining when the head of the instrument has reached the top of the chimney, so that no danger of thrusting off the iron smoke cowls is incurred. It works in a very cleanly manner entirely from below, and can easily be made fire proof when necessary.

7. Prevention of the Dry Rot.

Mr. John Shillibar, of Walkhampton near Plymouth, proposes to prevent the dry rot in timber, by cutting it down when all vegetation has entirely ceased, as at Christmas, instead of felling it immediately after the tree has recommenced its growing. In the last case it is said the pores are open and extended, the wood soft, the bark separates with ease, and when the juices of the tree have dried up, the pores remaining open, allow the wood to become infected with the disease. In the former the pores are considered as naturally closed, the sap and other easily changing fluids have descended into the root, or formed more solid matter, the bark adheres very closely and firmly to the wood, and the wood is much harder and more impenetrable, and is not affected by the dry rot. These conclusions have been drawn from a comparison of timber felled at different periods,

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II. Chemical Science.

§ 1. Chemistry.

1. Alkali from Potatoe Stalks.

The attention of the people of Ireland has been called to the extraction of potash from potatoe stalks. Processes for that

purpose have been commenced, and they promise to produce in that part of the British dominions a most important article of trade. It is calculated that 350,000 acres of land are annually cultivated with potatoes; these would produce 46.875 tons of potash, which, at £20. per ton, would amount to £937.500. per annum.

2. *Tungstic Acid.*

M. Chevreul has observed, that by heating the tungstate of ammonia with tincture of turnsole, the acid properties of the tungstic combination are rendered evident by the change of colour.

3. *Copper dissolved in Hydrogen.*

Hydrogen gas (says M. Lampadius) dissolves copper when it is passed over this metal in fine powder at a white heat. The gas then burns with a green flame, and forms, during its combustion, an oxide of copper.

4. *Homberg's Pyrophorus.*

Homberg's pyrophorus is said to be more certain in its preparation, when $\frac{1}{16}$ of sulphate of soda is added to the mixed alum and flour.

5. *Test for Sugar.*

It has been proposed by M. Doberenier, to test sugar in solution, in small quantities, by adding to a portion of the liquid, a few grains of yeast, and placing it in a vessel closed by mercury. A fermentation takes places, and the bulk of gas liberated indicates the quantity of sugar.

6. *Temperature on and beneath the Surface of the Earth.*

The mean temperature of Paris, deduced from many years observation, is 10° 6′ of the centigrade scale, = 51° Fahrenheit. The temperature of the caves beneath the Observatory have been for a long time 11° 71′ = 54° Fahrenheit. What is the cause of this difference of more than 1° between two results, = 3° Fahrenheit, which, according to theory, should correspond?

7. *Uranium.*

It has been ascertained by M. Chevreul that the peroxide of uranium is soluble in the alkaline sub-carbonates, and forms, with that of potash, a regularly crystallized salt. No carbonic

acid is disengaged. The solution is of a fine yellow colour, similar to that of the chromate of potash.

8. *Chromic Oxide and Acid.*

Chromic oxide heated with alkali becomes chromic acid, and chromic acid heated with an acid becomes chromic oxide; the oxide in solution is green, and the acid yellow, and the change of state and colour may be produced successively at pleasure.

9. *Cocoa Nut Oil.*

Cocoa nut oil is perhaps the most volatile of what are called the fixed oils; when heated, it distils over with scarcely any decomposition, and the part distilled, when washed, is similar to the original oil.

10. *Wire Gauze Safety Lamp.*

To shew how far the security afforded by means of wire gauze might be applied to the procuring light in the mines, Sir H. Davy has lately made an Argand's lamp safe by means of it. It required no glass, the cylinder of gauze supplying its place. It, as was expected, answered perfectly.

11. *Snake Stones.*

Dr. Davy has lately analysed the snake stones of India. He found them to be of three kinds; one was merely calcined bone; another carbonate of lime, coloured by a vegetable substance; and the third a bezoar stone. The idea entertained by the natives, of their power over the bite of poisonous snakes, is entirely unfounded.

12. *Strength of Ale.*

Ale brewed by Sir Joseph Banks, being analysed at his desire by Mr. Brande, gave the following proportion of alcohol.

1. Malt to the hogshead 8 strike.* Hops to the hogshead 8 lbs. Brewed 11th January, 1816—contained 9.85 per cent. of alcohol.

2. Malt to the hogshead 10 strike. Hops to the hogshead 11 lbs. Brewed 27th February, 1815—contained 10.84 per cent. of alcohol.

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* By *strike* is meant a bushel measure of malt, not heaped up but *struck off* to a level with the rim.

13. *Change of Colour by Acids.*

The effects of muriatic acid gas and ammoniacal gas upon turmeric paper, are so similar, that it is difficult to distinguish the two by this test alone. The acid reddens it almost as much as the alkali. Phosphoric, nitric, muriatic, and particularly sulphuric acid, also redden turmeric paper; but in all these cases, water, even in small quantities, immediately restores the original colour.

14. *Yellow Dye.*

A chemist of Copenhagen is said to have discovered a brilliant yellow matter for dying, in potatoe tops. The mode of obtaining it, is by cutting the top when in flower, and bruising and pressing it to extract the juice. Linen or woollen soaked in this liquor during 48 hours, takes a fine solid and permanent yellow dye. If the cloth be afterwards plunged in a blue dye, it then acquires a beautiful permanent green colour.

15. *Analysis of Sweet Almonds.*

M. Boullay has given an analysis of sweet almonds as follows.—

Oil, - -	54
Albumen, -	24
Sugar (fluid) -	6
Fibre, - -	4
Gum, - -	3
Pellicles, -	5
Water, - -	3.5
Acetic acid and loss,	5
	100

16. *Cholesteric Acid.*

MM. Pelletier and Caventon have obtained a new acid from cholesterine or the pearly substance of human biliary calculi discovered by Poulletier-de-Laselle, and named by Chevreul. Cholesterine is to be heated with its weight of strong nitric acid until it ceases to give off nitrous gas. A yellow substance separates on cooling, scarcely soluble in water, and which, when well washed, is pure cholesteric acid.

It is soluble in alcohol, and may be crystallized by evaporation. It is decomposed by a heat above that of boiling water,

and gives products containing oxygen, hydrogen, and charcoal as their elements. It combines with bases, and forms salts. Those of potash, soda, and ammonia, are very soluble: the rest are nearly insoluble.

17. *Metallic Manganese.*

The properties of metallic manganese, reduced by M. Fischer of Schaffouse, are described in the Bibliothèque Universelle as follows:—The fracture is neither conchoidal nor crystallized, but irregular, and very similar to that of the sulphuret of iron, commonly called marcasite. The metal is of a white colour. It is harder than tempered steel, and cuts glass almost as well as the diamond. It is capable of scratching rock crystal. It takes a very fine polish, but the permanency is doubtful, in consequence of its affinity for oxygen. Placed in water for 24 *hours*, it becomes covered with a brown oxide. It acts sensibly on the magnetic needle, perhaps in consequence of a little iron. The specific gravity is 7.467.

18. *Analysis of Bitter Almonds.*

M. Vogel, in his experiments on and analysis of bitter almonds, gives the following proportions of the substances in 100 parts.

Peelings, - - -	8.5
Fixed oil, - - -	28.
Albumen, - -	30.
Sugar, - - -	6.5
Gum, - - -	3.
Parenchyma vegetable, - -	5.
Essential oil and prussic acid, -	

The essential oil appears to be a very singular substance. It is best obtained by distilling almond water with barytes, to separate the prussic acid. In close vessels it is very volatile; exposed to the air, it becomes solid, crystalline, inodorous, and of considerable fixity. The crystals are a compound of it with oxygen, for oxygen is absorbed during their formation, and if they are dissolved in hydro-sulphuret of ammonia, they are again decomposed, and the original odour and oil is produced.

19. *Venom of the Common Toad.*

M. Pelletier has given the following account of the venom of the common toad.

The fluid which in the common toad is contained in the vesicles which cover the skin is of a yellow colour, and an oily consistence. Exposed to the air, it soon becomes concrete, and if it be received upon a plate of glass it can be raised in the form of solid transparent scales after a few seconds. The venom of the toad, whether in the solid or the liquid form, is extremely bitter, acrid, and even caustic, it reddens strongly the tincture of litmus, and forms an emulsion with water. Cold alcohol scarcely acts upon it, but when hot it attacks and dissolves a part, and acquires a fawn colour. The portion undissolved in the alcohol is perfectly white, without odour or taste, and resembles gelatinous membrane.

The alcoholic solution scarcely reddens litmus, and even loses that property entirely by evaporation. As the alcohol is disengaged a fat oily matter separates, which concretes on cooling, is insoluble in water, a little soluble in ether, but much more so in alcohol. Taste bitter, but neither acrid nor caustic. Instead of reddening litmus it restores the blue colour if it has previously been changed by an acid. These phenomena seem to indicate: 1st, that the acid of the venom is volatile; 2nd, that it is partly saturated by a base to which it loosely adheres, and from which it may be separated by other acids.

The gelatinous matter insoluble in alcohol, dissolves in hot water, but not in cold. The solution on cooling becomes opalescent, and has a degree of consistency. The substance which might at first be taken for gelatine is proved by comparative experiments to be distinct from it. It is not precipitated either by solution of chlorine or infusion of galls.

It may be concluded that the venom of the toad contains 1, an acid partly united to a base, and constituting about one-twentieth part of the whole; 2, a bitter fatty matter; 3, an animal substance having some analogy to gelatine, but differing from it in certain points.

20. *Ignited Wire Lamp.*

Sir H. Davy in his researches on flame, ascertained a peculiar state of combustion at a heat below that of flame, and he rendered the phenomenon evident by causing it to take place round a platinum wire, which became and remained ignited, in consequence of the heat given out. The effect was shewn to be produced either by platinum or palladium wires, in atmospheres made explosive either by mixture with inflammable gases or the vapour of inflammable substance, as ether at common temperature, or warm spirits of turpentine, alcohol, &c. The experiment has lately been very ingeniously varied by making the heated wire volatilize the alcohol. A coil of platinum wire about the $\frac{1}{100}$ of an inch in thickness, and containing from 8 to 15 or 16 turns, is dropped on to the wick of a spirit lamp, so that part touches the wick and part remains supported above. On blowing out the flame of the lamp after it has been lighted, the wire will become ignited, and continue so as long as any spirit remains below.

It has been ascertained that camphor may be substituted for the alcohol, by introducing a cylinder of it in the place of the wick; the ignition is very bright and a pleasant odorous vapour arises from it. Oil of turpentine in the lamp also succeeds. The wire does not remain ignited, but the continuance of the effect is marked by the ascent of a dense line of vapour, which rises from the wire, and diffuses an odour by some thought agreeable.

By adding essential oils to the spirit or oil of turpentine below, it is probable that various aromatic odours might be obtained, and the lamp would perhaps replace the fumigating pastiles which are used for this purpose. In some trials of this kind, the wire was found to become covered with a coat of charcoal after some time, and then the effect ceases, but this could easily be burnt off by a spirit lamp.

21. *Changes of Colour by Heat.*

Change of colour dependant upon temperature alone, is a common phenomenon in chemistry. Several instances have been

given in the Annales de Chimie, by Gay Lussac. The following are some others.

Nitrous acid gas has its red colour very much heightened by heat; on cooling, it returns to its first appearance.

White oxide of zinc obtained by combustion becomes yellow when heated, but returns to white when cooled.

Red oxide of mercury obtained by heat from the nitrate, has its colour increased by heat, and diminished by cooling.

Red oxide of iron, prepared by heating the precipitate from green vitriol by an alkali, becomes dark brown or nearly black by heat, and on cooling, resumes its light red colour. Common red oxide also changes in the same way, but not so much.

Borax tinged emerald green by fusion with chromate of lead, becomes a fine brown when heated, and returns to its original green colour when cold.

White oxide of titanium heated, becomes lemon yellow; cooled, it returns to white.

Chloride of silver, when fused and cold, is transparent and colourless, if heated, it becomes brown, then deep reddish brown, and almost opaque; on cooling it retrogrades through the various shades it had taken, and resumes its original appearance.

An infusion of red cabbage, when cold, is of a fine blue colour; when heated, it becomes red or rather purplish, but on cooling, resumes its blue tint; and these changes may be repeated continually. If a similar infusion be rendered slightly green by a little alkali, the affect of heat is sufficient to counterbalance the influence of the alkali and the infusion appears blue; on cooling, the green colour which it resumes shews the alkali present. If a hot and a cold infusion of red cabbage be rendered similar in colour, by the addition of a little alkali to the former, they appear exactly alike by transmitted day-light, but transmitted fire or candle-light, makes the former appear red, and the latter greenish blue. A similar difference is observable in the two solutions prepared by dissolving oxide of nickel in ammonia, and by adding ammonia in excess to the nitrate of nickel; they are both

of a fine blue colour by transmitted day-light, but transmitted artificial light renders the latter red, though it does not alter the former.

22. *Babylonian Cement.*

A substance, said to be part of the walls of a Babylonian structure, has been analysed by M. Vauquelin, and gave the following results:

Water - -	7.33
Silex - -	48.33
Alumine - -	9.33
Oxide of iron -	15.
Lime - -	14.
Sulphate of lime -	5.
	98.99
Loss	1.01
	100.00

It was of a dark brown colour, of a bituminous appearance, but so hard as to resist the hammer; part of its surface was irregular, but smooth, and of a vitreous appearance; and it is supposed to have been a cement applied in the soft state but dried by heat. The quantity of oxide of iron is remarkable.

23. *On Chemical Nomenclature.*

The Society of Arts and Sciences at Utrecht, proposes the following prize question, to be decided on the 1st of October, 1818, fixing either a gold medal worth 30 ducats, or the same sum in cash, if preferred, for the best treatise written in either the Dutch, German, English, French, or Latin language, and sent in time, post paid, to the Secretary, Professor *Rossyn*, at Utrecht.

"Is the chemical nomenclature, as proposed by the famous Lavosier and his collaborators, and as has been afterwards adopted, with few alterations, by almost all chemists, such as is still satisfactory with regard to its principal characteristics, or do the modern discoveries, particularly those made in consequence

of Galvanic electricity, render a thorough reform of the same necessary? If so, upon what grounds is that nomenclature to be founded, and in what manner is it easiest to be accomplished?"

"If not, what alterations are required to be made in the present nomenclature, in order to make it accord with the present state of science?"

24. *Captain Bagnold on a Table Furnace.*

To the Editor,

Sir,

The peculiarity of pumice-stone as a slow conductor of heat, though, doubtless, known to many, has, I believe, escaped general observation: I therefore take the liberty of transmitting you an account of a furnace in miniature, constructed of that material; and from the intensity of the heat it affords, I am induced to think, it will form a very useful instrument, especially when operating on small quantities.

The furnace is made in two pieces, which are ground to fit close on each other; the upper piece has a cylindrical perforation entirely through it, and the lower one merely a cup countersunk in the surface, with a lip or channel to conduct the blast into it. In a furnace of this construction, from 6 and $\frac{1}{2}$ to 7 inches in height, urged by a small pair of table bellows, I have produced malleable copper from the native red oxide. I intend trying some different modifications of the experiment, the result of which I shall be happy to communicate. I am Sir,

Your obedient humble Servant,

T. M. Bagnold.

7, *High Row, Knightsbridge,*
14*th March,* 1818.

25. *Manufacture of Calomel.*

The following process for the wholesale preparation of this important article of the Materia Medica is confidently recommended to the chemical manufacturer.

Prepare an oxy-sulphate of mercury, by boiling twenty-five pounds of mercury with thirty-five pounds of sulphuric acid, to dryness. Triturate thirty-one pounds of this dry salt with

twenty pounds four ounces of mercury, until the globules disappear, and then add seventeen pounds of common salt. The whole to be thoroughly mixed, and sublimed in earthen vessels. Between forty-six and forty-eight pounds of pure calomel are thus produced—it is to be washed and levigated in the usual way.

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§ 2. METEOROLOGY, ELECTRICITY, MAGNETISM, &c.

1. *Atmospherical Phenomena*, 1817.

The following atmospherical phenomena which occurred last year, are collected from the volumes of the Naval Chronicle: lightning was observed on 14 different days, thunder on 11, hail on 12, snow on 6, and there were six days in which the barometer was stationary. There were 42 gales of wind, viz. four from the N., two from the N. E., seventeen from the S. W., ten from the N., nine from the N.W. Fourteen rainbows, eight of which were perfect with their proper colours. Sixteen solar halos. Fifteen lunar halos. Twenty lunar coronas. One lunar iris, and one coloured paraselene. Eighteen small meteors, and two large ones half the apparent size of the moon at her greatest altitude. Two auroræ boreales, or northern lights.

2. *Luminous Meteor.*

Dr. Clarke of Cambridge has given an account of a large luminous meteor seen by himself and two other persons at 2 o'clock p. m. on Friday, February 6th. It descended vertically from the zenith towards the horizon, in the northern part of the hemisphere, and was very visible, though occurring in broad day-light, and opposed to the sun's orb, which was at that time shining with great splendour in a *cloudless* sky. From the form of the meteor and its rapid vertical course, a fall of matter from the atmosphere was expected. Dr. Clarke has ascribed its intense light to the heat evolved during its supposed formation in the solid state from some aeriform source.

The same meteor was seen at the same time, at Swaffham in Norfolk; and it is remarkable, that a slight shock of an earthquake, accompanied with noises, was heard and felt at Coningby, Holderness, and other places, on the same day.

3. *Meteor.*

A beautiful meteor with a long train was observed at Campbel Town, near Fort St. George, at 6 o'clock on Wednesday evening, January 28th. The diameter of the ball appeared to be about one foot to the naked eye, and the length of the train about six feet. It proceeded in a course due east.

4. *Luminous Phenomenon.*

The following phenomenon was observed near Arberg, in the kingdom of Wirtemberg. Several long luminous rays, probably phosphoric, issued from the earth upwards, and after shedding brilliancy around them gradually grew paler and became extinct.

5. *Luminous Meteor.*

On Sunday the 15th of February, at six o'clock in the evening, whilst a number of the inhabitants of the town of Agen, in France, were collected together to view the ascent of a baloon, a luminous meteor similar to those called *bolides* appeared, and was observed by the whole of them.

The sky was serene, the moon dimmed by clouds, and the wind at south-east; a brilliant flash of lightning occurred, and a twisted luminous train was seen, which ascended obliquely, and appeared to lengthen from one end only. This phenomenon disappeared, and was succeeded by a contorted long white cloud, extending north and south.

In four or five seconds this cloud gathered together, and then slowly divided into two parts, one of which remained nearly stationary, whilst the other moved off towards the north. A dull rolling sound was then heard similar to the noise of a carriage. The time which elapsed between the appearance of the lightning and the thunder, or noise, was very nearly two minutes and thirty seconds.

These phenomena generally accompany the fall of aerolites, but none have yet been found which had fallen on the present occasion.

The cloud appeared at an angle of sixty-five degrees nearly, and was observed for more than a quarter of an hour. It

moved from east to west, as did the other clouds, but more rapidly. *Moniteur, Feb. 24th.*

6. *Water-spout.*

On Saturday March 7th, an immense water-spout descended at Stenbury near Whitwell, in the Isle of Wight. The weather was very stormy immediately before its fall, and for one half hour was in a continual terrific roar. The descent of the water was compared to the influx of the sea, so great was its quantity, and destruction to those on the spot appeared inevitable. Walls were broken down, and cattle were carried away and dispersed.

7. *Increase of a Glacier.*

The glacier of Ortler in the vicinity of Chiavenha in the Tyrol, has, notwithstanding the late moderate winter, increased in a very extraordinary degree. A stream which formerly ran from this glacier has ceased to flow since Michaelmas 1817, and incessant subterraneous noises and roarings which are heard from beneath the ice are attributed to the collection of waters within the glacier. The glacier in the valley of Nandersberg has presented similar appearances, and great fears are entertained for the neighbouring country in both these places on the liberation of the confined waters on the approach of summer.

8. *Earthquakes on the Continent.*

During the storm which raged on the 23rd of February over Provence and the northern part of Italy, many towns were thrown into great disorder by repeated shocks of earthquakes. At Turin two shocks were felt, and at Genoa, Savena, Alanco, and San Remo, they were repeated at intervals during two days, and at some towns several houses were injured.

At Antibes in Provence the weather was very rough; a few minutes after seven in the evening of the 23rd, a tremendous rush of wind took place, and then sank into a calm, a dull subterranean noise was heard, the sea suddenly dashed against the rocks, and in three seconds three oscillations of the earth were felt, proceeding from south-east to north-west. The

wind then rose, and the storm raged as before. At twelve o'clock a fresh shock was felt, and next morning near mid-day, another also, preceded by the same smothered rumbling noise. The shocks were felt throughout the whole of Provence, where no earthquake had been experienced for eleven years.

9. *Earthquake in France.*

A slight earthquake was felt at Marseilles on the 23d of February, at seven o'clock in the evening, and on the 24th, at eleven o'clock in the morning. The same phenomena occurred also on the 19th, at Roffach Soietz and Beffort in the Upper Rhine.

On the 24th and 25th several shocks of earthquakes were felt at Var.

10. *Earthquake in England.*

A slight shock of an earthquake was experienced at Coningby in Lincolnshire on the 6th of February, which lasted some seconds. A noise like the subterraneous firing of cannon was heard at the time, and the windows of the houses in the town were much shaken. At the same time a similar phenomenon was experienced at the east end of Holderness, where the noise strongly resembled that of horses running away with a waggon, and it is said that the drivers of several teams drew up to the road side to make way for what they supposed the cause of the sound. A gentleman, who with his servant and labourer, were in the neighbourhood of Trentfall, about fifty miles from Coningby, also heard the noise. It lasted about two minutes, and at first consisted of noises exactly resembling gun shots at equal distances of about a second, each loud and distinct, afterwards it fell away to a kind of grumbling, which gradually ceased. The noise appeared to shift in a direction from east towards the south.

11. *Earthquake in Greenland.*

A severe shock of an earthquake was experienced at Greenland in the night of the 22d of last November. Hekla was perfectly quiet at the time.

12. *Extraordinary Fall of Rain.*

On the 21st of October, 1817, (the day the hurricane commenced in the West Indies) at the Island of Grenada, with the wind west, and the barometer at 29.40, eight inches of rain fell in twenty-one hours, and the rivers rose thirty feet above their usual level. From the 20th of October to the 20th of November, seventeen inches of rain fell.

13. *Magnetism applied as a Test for Iron.*

The third Number of the Annales des Mines contains a paper by M. Haüy on the means of detecting iron in mineral, or other substances, by magnetism. Its presence is ascertained by the attraction of the substance, either immediately or after having been heated in the flame of a taper, on the magnetic needle, but in order to make the effect more sensible and evident, M. Haüy has taken advantage of the combined forces of the magnetism of the earth and of a bar magnet acting simultaneously on the needle.

The needle should be of excellent steel, and highly magnetic, its cap should be made of agate or rock crystal, and the point on which it moves very fine. If such a neeedle be left to itself it will stand parallel to the magnetic meridian, in consequence of the forces exerted on it by the magnetic poles of the earth, and if from any cause the needle is deflected from this line, the force exerted upon it to bring it back to its first position will be as the sine of the angle which the needle makes with the magnetic meridian. The power, therefore, which tends to return the needle to its first position, increases until it has passed through a quarter of a circle, and then decreases again, but the increase is in a decreasing ratio, and the decrease in an increasing ratio; and supposing the needle to be moved through 90° by nine successive additions of force, it would require the greatest addition, to move it from 0 to 10°, and the least to move it from 80 to 90°; and then if the power which moved it from 80 to 90° carry it over that point, it would be more than sufficient to make it traverse the next quadrant, because the forces exerted by the earth's magnetism continually decrease.

In order to take advantage of this circumstance, let the needle be influenced only by the earth's magnetism, it will stand parallel to the magnetic meridian; then if the south pole of a bar magnet be approached towards the similar pole of the needle, the bar being in a line with the needle, a repulsion will take place, and the needle will deviate until the repelling power of the bar and the attractive force of the earth on it, are equal to each other. This may have set the needle at an angle of 30° with its meridian; then by approximating the bar, the effect belonging to it will be increased, and the direction of the needle will become more oblique. By adjusting the bar in this way, the needle may be placed and retained in a position very nearly at right angles with its first direction; and then as the power of the earth on the needle increases but very little from the 80° or 85° to 90°, and afterwards diminishes, a small force will make it pass the 90°, and once beyond that point it will continue to move until its position is completely reversed.

The time of applying a mineral or other substances supposed to contain iron to the needle, is then when it is nearly at right angles with the magnetic meridian; because an effect will be produced there by a force many times smaller than that necessary to produce a similar effect on a needle uninfluenced, except by the earth's magnetism.

M. Haüy found that in this way effects were produced on the needle by bodies that in common circumstances appeared to have no action, as hæmatite, the carbonate, phosphate, chromate, and arseniate of iron, ferriferous carbonate of lime, garnet, peridot, &c.; and he observes that this extension of character by means of *double magnetism* may be usefully employed, in the description of ferriferous minerals. As the garnet and peridot are the only gems of their own colour that have been observed to affect the needle, this character may be combined with their physical properties to distinguish them, and other stones, when cut into arbitary forms by the lapidary.

14. *Morrichini's Experiment in Magnetism.*

Mr. Playfair appears to have made with success whilst at Rome, the doubtful experiment of Dr. Morrichini on the communication of magnetism to a steel needle by the violet rays of the solar beam. The arrangement of the apparatus was in the old form, and the time required to produce the effect was 55 minutes.

III. Natural History.

§ 1. Botany.

1. *Native Country of the Potatoe.*

Don Jose Pavon, the celebrated author of the Flora Peruviana, who resided many years in South America, says, "The Solanum *tuberosum* grows wild in the environs of Lima, in Peru, and 14 leagues from Lima, on the coast. I have also found it wild in the kingdom of Chili." The Indians cultivate it in great abundance in Peru and Chili, and call it Papas. It is said also to have been found in the forests near Santa Fè de Bagotá.

2. *Alder Tree.*

The Earl of Carlisle has an alder tree now growing on his estate in Cumberland, which, about three feet above the ground, is more than nine feet in circumference. His Lordship has also in Geltsdale Forest, three distinct species of trees growing out of one common solid trunk. A common ash, a mountain ash, and an alder.

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§ 2. Mineralogy, Geology, &c.

1. *Pargasite, a new Mineral.*

A new mineral, called Pargasite has been sent to this country from Finland. It was found some years ago at the village of Ersby, near Abo.

It is of a green colour; is translucent and transparent. Its crystals are of various sizes, from an inch downwards. Its form is an octohedron, with a rhomboidal base. It has three

cleavages. It is harder than fluor spar, but is scratched by quartz. It also scratches glass. Specific gavity 3.11. It melts before the blow pipe into a mass of a pearly white lustre.

The following are given as the proportions of its constituents,

Silex, - -	42.01
Magnesia, - -	18.27
Lime, - -	14.28
Alumina, -	14.08
Oxide of iron, -	3.52
——— manganese, -	1.02
Oxide of a metal not investigated,	33
Fluoric acid and water, -	3.9
Loss, - -	2.59
	100.

2. *Instrument to distinguish Minerals.*

Dr. Brewster has lately constructed an instrument for distinguishing the precious stones from each other, and from artificial imitations of them, even when they are set in such a manner that no light can be transmitted through any of their surfaces. The same instrument may be employed to distinguish all minerals that have a small portion of their surface polished either naturally or artificially. The application of the instrument is so simple, that any person, however ignorant, is capable of using it.

3. *Silicated Hydrate of Alumine.*

A combination of alumine, silex, and water has been found native by M. Lelièvre, and lately analysed. It was discovered in 1786, in the gallery of a lead mine, on the bank of the river Ou, in the Pyrénées. It is opaque and white, but sometimes slightly yellow or green. In its natural situation it was soft, and perpetually moistened by a small stream of water. When dry, the fracture was resinous. It barely scratched carbonate of lime, adhered to the tongue, and put into water absorbed

about ¼ of its weight. Heated, it became friable and light, and lost 40 per cent. It was infusible before the blow pipe. When acted on by acids, it assumed a gelatinous appearance. An analysis by M. Berthier gave,

Alumine, - -	44.5
Silex in combination,	15
Water, - -	40.5
	100

It has been named Silicated Hydrate of Alumine (alumine hydratée silicifère).

4. *Native Copper.*

An enormous mass of native copper has been found in North America by M. Francis le Baron, of the United Sates. It was discovered in the bed of the river Onatanagan, and measures 12 feet round at one end, and 14 feet at the other. It is supposed to have been detached from some distant source, and brought by the force of the waters to its present situation. The pieces that have been taken from it appear to be very pure; they are extremely ductile, malleable, and capable of being highly polished.

5. *Fossil Bone of a Whale.*

Part of the jaw bone of a whale was dug up a short time since, in Roydon gravel pit, near Diss. It measured 20 inches in girth, but was not above nine inches long. The outside was penetrated by lapideous matter, but the inside was similar in every thing to recent bone, except in the colour, which had been given it by the stratum in which it lay. Its present form and appearance are attributed to the attrition it is supposed to have suffered at former times. The ends are so worn that they seem rather artificial than natural.

6. *Remains of a Mammoth.*

A fisherman of Philipsbourg, on the Rhine, lately drew up in his net the foot and the *omoplate* of a mammoth. These

curious remains were sent to the King of Baden's Cabinet of Natural History at Carlsruhe.

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§ 3. Medicine, &c.

1. *Bite of the Adder.*

Dr. Leslie, in a communication to the Medical Journal, describes a case in which ammonia was successful in preventing the effects of the bite of an adder. Travelling in the North of England, he stopped to give assistance to a poor man who, having laid down on the grass to sleep, had been bitten. From experience of the beneficial effects of ammonia in India, in cases of the bites of different snakes, Dr. Leslie procured some spirits of hartshorn, and gave about a drachm of it, mixed with about half an ounce of gin, and a little water. The effect was very sudden. In ten or fifteen minutes the patient's eyes became more bright, his pulse fuller and stronger, and his countenance altogether more cheerful; and by the repetition of the same dose as above stated, in about the space of an hour and a half, he appeared perfectly recovered. Another dose was left to be taken at ten o'clock at night, and in the morning he said he was quite well, except a little numbness and weakness in the arm; the third day after he returned to his work.

2. *Cure for the Hydrophobia.*

Dr. W. Rittmeister, of Powlowsk, Finland, has collected together a number of striking cases, and also several authorities, by which he endeavours to prove that blood when drank is a remedy for the hydrophobia, even when the symptoms have become very marked. When a man or an animal has been bitten by a rabid dog, wolf, or other creature, it is the custom in those parts to kill the diseased animal and give its blood to drink to those that have been bitten; they remain in health, and the wounds are treated in the common way.

It is further said, in a letter from Dr. Stockman, in White Russia, to Dr. Rittmeister, that the blood of the person or

animal bitten is sufficient to prevent the effect of the poison; the little finger of the left hand is opened by a needle or lancet, and a small quantity of blood being received is drank, sometimes being previously mixed with other things. The country people in Dr. Stockman's neighbourhood, when a dog of theirs is bitten by a rabid animal, cut his tail to make it bleed, and the dog by licking it saves himself from death.

The paper of Dr. Rittmeister is published in the 2nd Number of the Hamburgh Medical Repository.

3. *Russian Remedy for Hydrophobia.*

" Take a good sized root of Alisma plantago and two or three small ones, pound or reduce them all into a very fine powder, which spread on a piece of buttered bread and give to the patient. Two doses, or three at most, are sufficient to eradicate the virulency of the poison, let it be ever so violent, even if the patient be already in the worst state, so as to be afraid of water. The efficacy of this root cures also animals bitten by mad dogs, and even mad dogs themselves. During the last 25 years this remedy has not once failed, but has uniformly been a sure means of successfully restoring every person to their former health without any bad consequences afterwards, even those who from the violence of the poison rushed upon people and bit them; which facts are particularly ascertained in the government of Tsola.

The plant may be gathered during the whole of the summer, but it operates more efficaciously if gathered at the latter end of August, the roots of it being taken up and washed clean from mud or other earthy matter, must be dried." (*Translated from the Russian, as communicated in a letter to Sir Walter Farquhar.*)

General Literature, and Miscellaneous Communications.

1. *Ancient Manuscripts.*

A Neapolitan Abbé, Janelli, has discovered in the Royal Library at Naples, a manuscript of Dracontius, a poet of the 5th century. It contains ten small poems hitherto unknown, upon mythological subjects.

2. *Ancient Tomb.*

In clearing the site for the erection of a new church at Dunfermline, a tomb has been discovered, which is supposed to be that of Robert Bruce, King of Scotland. A trough of polished stone contains the skeleton. The body, which is six feet two inches in length, appears to have been wrapped in fine damask interwoven with gold, of which some fragments remain.

3. *Ancient Subterranean Apartments.*

About the middle of February, some men in the employment of Sir W. Hicks, Bart., while digging up the roots of an old ash tree, which they were employed to fell, at Cooper's hill, about four miles from Gloucester, came to a large stone that excited their curiosity. On removing it, they discovered a flight of steps leading to an apartment, in the centre of which was a cistern about a yard square; in clearing the room, the skulls of a buffalo and a bullock, with horns complete, and the remains of a fire place, with a quantity of wood ashes were likewise found. A fortnight afterwards, four more apartments were discovered, in one of which is a very curious tesselated pavement (the tessera are cubes of about half an inch), also the remains of several urns and figured tiles of Roman pottery. The walls of one of the apartments, and also the passages, are painted in *fresco*, with alternate stripes of purple, yellow, and scarlet, all of which are beautifully shaded and curiously ornamented with scrolls and a border. These inter-

esting remains of antiquity have probably existed for upwards of 17 centuries.

4. *Site of the Temple of Concord at Rome.*

The site of the ancient Temple of Concord at Rome, appears at last to be fixed with a considerable degree of probability. The Abbé Carlofea, in the Diario Romano, supposes it to have existed in the middle of the place which is before the Temple of Jupiter Tonnant, i. e. between the Arch of Septimus Severus and the Capitol. His proofs are besides the occurrence of many sculptured remains, various inscriptions which have been found on the spot relating to the temple; and he still farther supports his opinion, by shewing its accordance with the descriptions given of that temple by antient writers.

5. *Ancient Model of Measures.*

A model has been discovered at Pompeii, which served to fix the measures both for solids and fluids. It consists of larger and smaller cylinders, with inscriptions. There is an inscription on the outside of the stone, which states, that it was made by order of the Decemvirs. M. Romanelli has recognized the measures, mentioned by the Roman authors, under the names of Modius, Semimodius, Trimodius, Amphora, Congius, Hemina, Libra, and Quartarius. This valuable relic is deposited in the Museum at Portici.

6. *Ancient Coin.*

An ancient gold coin was some little time since found by a labourer in Holland Park. It is in excellent preservation, is considered as a British coin, and supposed to be from the mint of Cassibelan or Cunobelin, a monarch who reigned about 60 years before the Christian æra. The impression on it is that of an ear of corn. It is the property of Mr. P. Turner of Easthothly, who a short time since possessed a similar coin, found in the same place.

7. *Haches de Pierre.*

There have been found in France, at various times, particu-

larly in the departments of Indre and Loire, and de la Vienne, certain implements formed of stone, which have been called *haches de pierre*. M. Dutrochet describes their form as being that of an acute isosceles triangle, having the summit removed, and the base being formed into a cutting edge. Their length is from 5 to 8 inches, their width from 2½ to 4 inches, and they appear to have been formed by friction on a larger rough stone. The stone of which they are formed, is generally siliceous, a white opaque quartz, but some are of basalt, and a very few of jasper; and it is to be observed, that the two latter substances are not found naturally in the department of Indre and Loire, where the implements formed of them are most frequently met with.

From the absence of all asperity or projection on the surface of these *haches*, it is concluded that they were not furnished with handles, but held immediately in the hand. They are supposed to have been used for domestic purposes as well as in war. Historical information retraces the state of this country as far back as to the foundation of Marseilles, by the Phocéens, in the year 590 B. C. an interval of more than 2400 years from the present time; but as the Gauls are supposed to have been to a certain degree civilized at that time, so much so, as to have had a knowledge of the metals, and their applications to the formation of useful instruments, and missile weapons, the age of these ancient stone implements is supposed to be at least 3000 years.

8. *Commerce.*

The following extraordinary exportation (deduced from a calculation) in two articles only, has taken place at Liverpool, between the 10th of October and the 5th of January last:

Of cotton stuffs	-	24,885,335 yards
Of cotton stockings	-	380,244 pair

The amount of exports for these two months in these articles alone, averaging cottons at one shilling per yard, and stockings at two shillings per pair, is 1,279,791 pounds three shillings.

9. *On the Use of Salt in feeding Cattle.*

Lord Somerville attributes the health of his flock of 203 Merino sheep, which he purchased in Spain, principally to the use which he has made of salt for the last seven years on his farm. These sheep having been accustomed to the use of salt in their native land, his Lordship considered, that in this damp climate, and in the rich land of Somersetshire, it would be absolutely necessary to supply them with it regularly. A ton of salt is used annually for every 1000 sheep; a handful is put in the morning, on a flat stone or slate, ten of which set a few yards apart are enough for 100 sheep. Twice a week has been usually found sufficient. Of a flock of near 1000, there were not ten old sheep which did not take kindly to it, and not a single lamb which did not consume it greedily. Salt is likewise a preventive of disorders in stock fed with rank green food, as clover or turnips, and it is deemed a specific for the rot.

10. *Lithovasa.*

The Oolite or freestone found at Bath, is very soft and porous, is easily penetrated by, and absorbs a considerable quantity of water. It has of late been formed into wine-coolers and butter jars in place of the common buiscuit ware, and from the facility with which the water passes through it, so as to admit of evaporation at the surface, it succeeds very well. The most ingenious application of this stone is in the formation of circular pyramids, having a number of grooves cut one above the other on its surface; these pyramids are soaked in water, and a small hole made in the centre filled; salad seed is then sprinkled in the grooves, and being supplied with water from the stone, vegetates; and in the course of some days produces a crop of salad ready to be placed on the table. The hole should be filled with water daily, and when one crop is plucked, the seeds are brushed out and another sown. They are sold at 448, Strand.

11. *African Expedition.*

A letter from Sierra Leone, mentions the return to that place of the scientific expedition for exploring the interior of Africa.

They were completely unsuccessful, having advanced only about 150 miles into the interior from Rio Nunez. Their progress was then stopped by a chief of the country, and after unavailing endeavours for the space of four months to obtain liberty to proceed, they abandoned the enterprize and returned. Nearly all the animals perished. Several officers died, and but one private, besides one drowned, of about 200. Captain Cambell died two days after their return to Rio Nunez, and was buried in the same spot where Major Peddie and one of his officers were buried on their advance.

12. *Saxon Piece of Antiquity.*

A letter from J. D. Strutt, Esq. to the Editor of the Annals of Philosophy, describes a large block of stone which was discovered a few months ago in lowering Chaddesden Hill, about a mile to the east of Derby. The stone measures about two feet in length, 20 inches in width and 14 inches in height, and weighs about 4 hundred weight and a half. It has the appearance of an irregular rounded boulder, and consists of greenstone interspersed with hornblende. It is hard, and quite unlike any stone found in the neighbourhood. A number of bones were found beneath it. It is supposed that this stone had been placed in this situation by the Saxons to mark the boundary between the borough of Derby and Chaddesden, and that it had been selected and brought from some distance, from its dissimilarity to any stone found in the neighbourhood. The bones are imagined to be those of the animal sacrificed at the setting up of this mark.

13. *Fine Arts at Rome.*

Late accounts from Rome notice the encreasing attention and encouragement given to the fine arts in that city. The Chevalier Thorwaldson is employed in restoring the last of the statues of Ægina. These chefs d'œuvre have filled him with the ambition of himself producing a figure of Hope in the antique style. Count Sommariva, one of the richest protectors of the arts in Europe, has given Thorwaldson an order to execute for him in marble, *The Entrance of Alexander into Babylon*, upon the

design of that which is so much admired in stucco at the Palace of Monte Cavallo. Canova has now finished the group of Love and a Nymph, which the Prince Regent of England ordered of him. The Neapolitan Minister, the Marquis de Foscaldi, has caused three frescos of Dominiquin, which were in the two dark chambers and in a Portico of the Palace Farnese, to be transferred to canvas—an operation which perfectly succeeded.

14. *Antiquities.*

Letter from Odessa, January 27th.—Archæology is indebted to the Count de Langeron, Governor General of New Russia, for several interesting discoveries in the Ancient *Panticapæum*, now *Kertch*, formerly the capital of the European states of Mithridates, where a seat hewn in a rock is still known by tradition as the *seat of Mithridates.* After some excavations made by order of his Excellency in some of the tombs or *tumuli*, several ancient vases of different dimensions were found, some of which are of the finest workmanship, and in excellent preservation, with various small busts and remains of ancient statues, utensils, rings, remains of ancient armour, offering to the learned many opportunities of research relative to a country which may be called classic, now making part of the empire of Russia. Count de Langeron is endeavouring to determine the situation of the ancient temple of Diana, so celebrated in the history of Iphigenia and Orestes, and also to verify upon the spot the description of Strabo. These researches have proved, from the precision and exactness with which the environs of the temple are described, that it must have stood about 104 stadia or six French leagues from the old city of Imbermann (the *Ctenos* of Strabo) at 20 versts from the new city of Svastopol, and near the circuit of the ancient and immense Chersonesian Heracleote, in the narrow streets of which a passage has been effected from 10 to 15 versts in a right line, and where are still to be seen the remains of several temples and other public buildings. The promontory on which the ancient Temple stood, is 800 yards above the level of the sea. Near some rocks at its base are some vast and deep caverns, which, if we are to admit the truth of an episode in the history

of Iphigenia, may have served as a refuge for Pylades and his companions. Traces of a road are still seen, which went from these caverns in the direction of the temple. The aspect of these savage regions, whence, on one side, nothing is perceivable but the sea, and on the other the horizon, is bounded by the black and barren mountains of Balachava (the ancient *Simbolon,*) and could not but augment the regrets of Iphigenia on finding herself separated for ever from the fine country of Argolis, where she was born. Several medals of the ancient Kings of the *Bosphorus* have been found.

15. *Ancient Remains.*

A letter from Largs in Scotland, dated January 27th, says that " In digging below one of the cairns of stone in the new town of Largs, south of the village, the site of the famous battle between Alexander III. King of Scotland and Haco King of Norway, there were lately found two urns made of coarse clay, apparently in a half burned state, and filled with bones evidently human. What is remarkable, is, that to all appearance the bodies had been burned, as part of them have that appearance, and were in small pieces. The length of the one urn was about eighteen inches, the other about a foot, both coarsely ornamented. The mouth of the largest was turned downwards and placed upon a smooth bit of freestone, the other had the mouth upwards, and was covered also with a piece of stone. A piece of metal, apparently brass, was found in the largest, about three inches in length and one broad, and appeared to be some part of the armour. In digging the foundations in the above ground, several small stone coffins were found, many of them containing bones which appeared to have been burned.

16. *Roman Coins.*

Whilst some workmen were digging about a fortnight ago, in a field belonging to Mr. Wicksted of Charlton in Cheshire, they found, about three feet below the surface, a broken Roman vase containing various coins of the Emperors Valerian and Posthumus.

17. *Ship discovered in the earth in Africa.*

A singular discovery has been made in the south of Africa, about ten miles north of Cape Town. Whilst digging in the earth a piece of timber was found buried, which on being traced, led to the complete disinterment of a ship, or other large vessel that was buried some feet beneath the surface. The wood is in excellent preservation, and appears to be cedar. A more complete account of this extraordinary circumstance is shortly expected.

18 *Venus de Medicis.*

The statue which was made by Canova to replace the original Venus de Medicis in the gallery at Florence, when removed by the French to Paris, is now in the possession of the Marquis of Lansdown. It is considered as one of the finest works of Canova, and equal in beauty to the original. The ancient Venus has been restored to Florence, and is now in the Palazzo Pitti.

19. *Roman Villa in Oxfordshire.*

The Roman Villa which exists near Stonesfield, about eleven miles from Oxford, was first brought into notice by the Rev. Mr. Brown in the year 1816. Since that time various and extensive discoveries have been made by that gentleman, and the Duke of Marlborough, on whose grounds these remains of ancient times are situated. The building encloses a space of about three acres, and the peristyle on every side of the quadrangle is very evident. The divisions of forty-seven rooms are easy to be distinguished. The pavements, which are tesselated, are in excellent preservation, and one of the large rooms is quite perfect. The variety of the tessera and the accuracy with which they are arranged and connected is very remarkable. The larger rooms seem to be about thirty feet long by twenty-five wide, and this proportion of length to breadth is generally preserved, a smaller one is exactly twenty-eight feet by twenty-four. The baths have been completely cleared out, and the hypocaust and flues by which they were warmed, apparently in a way very similar to that adopted in modern hot-houses, are apparent.

Nothing has yet been discovered that fixes with any degree of certainty the date of this place, but some coins of Constantine the Great have been collected. Those parts which are exposed to the air, and particularly the pavements, have been covered over with earth during the winter, to preserve them from the effects of frost, which is extremely injurious by loosening the small pieces of which they are made

20. *Antiquities in Egypt.*

In a letter from Egypt it is stated that the attempt to remove the colossal bust of Memnon from amidst the ruins of Thebes, made in the course of last year, had perfectly succeeded. It had been conveyed to Alexandria, where it was embarked for Malta, for the purpose of being brought to England. The bust is described as consisting of a single piece of granite, and the weight is computed at fourteen tons. Several excavations were made at the place, and a row of sphinxes of black marble with the bodies of lions and women's heads discovered; they were beautifully sculptured, and several of them quite perfect. Also a statue of Jupiter, of cream coloured marble. On commencing a second series of excavations after the bust had been conveyed to Alexandria, a beautiful colossal head of Osiris was discovered, one of the arms was also found, which measured eleven feet. After working for twenty days, a temple was opened containing fourteen large chambers, including a spacious hall, in which were found eight colossal statues thirty feet high, all standing, and quite perfect. Four others were found in the sanctuary. The walls were covered with hieroglyphics. A small statue of Jupiter found in the great hall, and two lions with ox heads were brought from thence to be conveyed to England.

21. *Height of Adam's Peak.*

Taking into account the equatorial correction for the diminution of the weight of mercury in the barometer, Dr. Davy has ascertained the height of Adam's Peak to be nearly 6500 feet.

22. *New Alcali.*

We understand that Professor Berzelius has sent an account to this country of a new alcali having been discovered in Sweden.

The discover has also ascertained the existence of a new inflammable body.

23.

A work containing coloured figures of the six known species of Strelitzia is preparing for publication from the admirable drawings by Mr. Francis Baüer. The work is to consist of sixteen plates in large folio, and they are coloured with the greatest care, and as nearly as possible resemble the original designs which have been so long admired in the splendid collection of Mr Baüer's Drawings in the possession of Sir Joseph Banks. The work is to consist of four numbers, each containing four plates. We have seen three of the plates which are already executed, and have no hesitation in pronouncing them superior to any coloured figures of flowers in any published work.

Some omissions in the List of Wines given in the last Number will be found rectified in the following Table, exhibiting the average Quantity of Spirit (alcohol) in different Kinds of Wine. By W. T. Brande, *Esq. Sec. R. S. &c.*

	Proportion of Spirit per cent. by measure.
1. Lissa	26,47
Ditto	24,35
Average	25,41
2. Raisin wine	26,40
Ditto	25,77
Ditto	23,20
Average	25,12
3. Marsala	26,03
Ditto	25,05
Average	25,09
4. Port	25,83
Ditto	24,29
Ditto	23,71
Ditto	23,39
Ditto	22,30
Ditto	21,40
Ditto	19,00
Average	22,96
5. Madeira	24,42
Ditto	23,93

		Proportion of Spirit per cent. by measure.
5.	Madeira (Sercial)	21,40
	Ditto	19,24
	Average	22,27
6.	Currant wine	20,55
7.	Sherry	19,81
	Ditto	19,83
	Ditto	18,79
	Ditto	18,25
	Average	19,17
8.	Teneriffe	19,79
9.	Colares	19,75
10.	Lachryma Christi	19,70
11.	Constantia, white	19,75
12.	Ditto, red	18,92
13.	Lisbon	18,94
14.	Malaga (1666*)	18,94
15.	Bucellas	18,49
16.	Red Madeira	22,30
	Ditto	18,40
	Average	20,35
17.	Cape Muschat	18,25
18.	Cape Madeira	22,94
	Ditto	20,50
	Ditto	18,11
	Average	20,51
19.	Grape wine	18,11
20.	Calcavella	19,20
	Ditto	18,10
	Average	18,65
21.	Vidonia	19,25
22.	Alba Flora	17,26
23.	Malaga	17,26
24.	White Hermitage	17,43

		Proportion of Spirit per cent. by measure.
25.	Rousillon	19,00
	Ditto	17,26
	Average	18,13
26.	Claret Chateau Margot	17,11
	Ditto	16,32
	Ditto Lafite	14,08
	Ditto	12,91
	Average	15,10
27.	Malmsey Madeira	16,40
28.	Lunel	15,52
29.	Sheraaz	15,52
30.	Syracuse	15,28
31.	Sauterne	14,22
32.	Burgundy	16,60
	Ditto	15,22
	Ditto	14,53
	Ditto	11,95
	Average	14,57
33.	Hock	14,37
	Ditto	13,00
	Ditto (old in cask)	8,88
	Average	12,08
34.	Nice	14,63
35.	Barsac	13,86
36.	Tent	13,30
37.	Champagne (still)	13,80
	Ditto (sparkling)	12,80
	Ditto (red)	12,56
	Ditto (ditto)	11,30
	Average	12,61
38.	Red Hermitage	12,32
39.	Vin de Grave	13,94

* See vol. i. p. 186, of this Journal.

	Proportion of Spirit per cent. by measure.
39. Vin de Grave.........	12,80
Average	13,37
40. Frontignac	12,79
41. Cote Rotie	12,32
42. Gooseberry wine	11,84
43. Orange wine,—average of six samples made by a London manufacturer.	11,26
44. Tokay	9,88
45. Elder wine	8,79
46. Cyder, highest average	9,87
Ditto lowest ditto......	5,21
47. Perry, average of four samples	7,26
48 Mead	7,32
49. Ale (Burton)	8,88
Ditto (Edinburgh) ...	6,20
Ditto (Dorchester) ..	5,56
Average	6,87
Ditto (Lincolnshire) see page 124.............	10,84
Ditto (ditto)..........	9,85
50. Brown stout	6,80
51. London Porter (average)	4,20
52. Ditto small beer (ditto)	1,28
53. Brandy	53,39
54. Rum	53,68
55. Gin	51,60
56. Scotch Whiskey .	54,32
57. Irish ditto	53,90
58. Hollands (genuine)....	56,00

Art. XVII. *Narrative of an Expedition to explore the River Zaire, usually called the Congo, in* 1816, *under the direction of Captain Tuckey, published by permission of the Lords Commissoners of the Admiralty.—Murray,* 1818.

Our knowledge of the continent of Africa has in no wise kept pace with our encreased and encreasing knowledge of the other parts of the globe, and although we may have obtained more precise information respecting the outline of its coasts than the ancients, it may be doubted whether their knowledge of the interior did not surpass ours. The object of the voyage, the narrative of which has been just published, was planned and undertaken with the view, and in the hope

of solving the great geographical problem respecting the *Niger*, which has for a considerable time excited the attention of the scientific world. We are indebted for the greater part of what is known respecting the interior regions of Africa to the Arabian writers of the middle ages, and the information of Arabian travellers of our own times; after these the Portuguese were the first Europeans who penetrated beyond the coast into the interior, and they probably collected much information; but it was the policy of that nation to conceal what they discovered till it has been lost even to themselves. The Portuguese followed the Arabian writers in describing the course of the Niger as flowing from east to west, which Herodotus had learned nearly 20 centuries before to flow in a contrary direction, but this question was at last completely set at rest by Mr. Park; but another question respecting this great river remains to be solved,—where is its termination? As ancient authorities had pointed out the true direction of the stream, it was but fair to allow them credit for a knowledge of its termination. In the examination of this part of the question, by Major Rennell, the authorities of the Arabian writers are weighed and compared with the geography of Ptolemy; and after a close and accurate investigation of the various statements of ancient and modern authorities, and a train of reasoning clear and argumentative, the result of the enquiry appears to be, that the Niger loses itself in the extensive lakes or swamps of Wangara; an hypothesis, which was supposed to have the merit of falling in pretty nearly with the termination of that river, as assigned to it by Ptolemy, in what he called the Libya Palus, which lake, however, Ptolemy only says, is formed by the Niger. In addition to this coincidence, there were also negative proofs of the disappearance of the Niger in the interior regions of Africa. It could not, for instance, be a branch of the Egyptian Nile, as the Arabs generally contend, for the two reasons adduced by Major Rennell; first, because of the difference of level; the Nile, according to Bruce's measurement by the barometer, passing over a country whose surface is very considerably higher than the sink of

North Africa, through which the Niger is stated to flow. Secondly, because the Nile of Egypt, in this case, must necessarily be kept up at the highest pitch of its inundation for a long time after that of the Niger, which is well known to be contrary to the fact. Neither was it probable, that its waters were discharged into the sea on any part of the eastern coast, there being no river of magnitude on the whole extent of that coast, from Cape *Guardafui* to Cape *Corientes*. The hypothesis therefore, of the dispersion and evaporation of the waters of the Niger, in lakes of an extended surface, was the most plausible, and perhaps the more readily adopted, as it fell in with ancient opinion.

The stream of this mysterious river being now traced with certainty from west to east as far as Tombuctoo, so little suspicion seems to have been entertained of the probability of its making a circuitous course to the sea on the western coast, near to which it has its source, that the examination of this side of Africa seems entirely to have been left out of the question. But when Park was preparing for his second expedition to explore the further course of this river, it was suggested, that the Congo or Zaire, which flows into the Southern Atlantic about the sixth degree of south latitude, might be the outlet of the Niger; and as this suggestion came from Mr. Maxwell,* who, in the capacity of an African trader, had not only become well acquainted with the lower part of the river, but had actually made a survey of it, the idea was warmly espoused by Park, who, in a memoir addressed to Lord Camden, previous to his departure from England, assigns his reasons for becoming a convert to this hypothesis; and adds, that if this should turn out to be the fact, "considering it in a commercial point of view, it is second only to the discovery of the Cape of Good Hope; and in a geographical point of view, it

* Mons. Malte le Brun (Geograp. Universelle) states this conjecture to have originally been made by M. Seetzen more than sixteen years since, but was afterwards abandoned by him. Corresp. Geo. et Astron. de Mons. Zach, v. 260.

is certainly the greatest discovery that remains to be made in this world."

Major Rennell, however, gave Park no encouragement to hope for the confirmation of this hypothesis. But the impression which the facts stated by Mr. Maxwell, and his reasoning on those facts, had made on Park's mind previous to his leaving England, so far from being weakened, appear to have gathered strength on his second progress down the river; and it can hardly be doubted that the unknown termination of the stream, and of his own journey, was the unceasing object of his anxious enquiries; the result of which was, as we are told by his biographer, that "he adopted Mr. Maxwell's sentiments relative to the termination of the Niger in their utmost extent, and persevered in that opinion to the end of his life;" but it was not the fate of that adventurous traveller, to ascertain the truth or falsity of Mr. Maxwell's hypothesis, and the termination of the Niger and the source of the Congo are still unknown. It is only surprising that a river of that magnitude and description which belong to the Congo, should not, long before now, have claimed a more particular attention. It is true the first notice of this river is but vaguely given; Diego Cam, in proceeding down the coast, observed a strong current setting from the land, the waters of which were discoloured, and when tasted found to be fresh. These circumstances led him to conclude, that he was not far from some mighty river, which conclusion was soon confirmed by a nearer approach. He named it the *Congo*, as that was the name of the country through which it flowed, but he afterwards found that the natives called it the *Zaire;* two names which, since that time, have been used indiscriminately by Europeans. It now appears that Zaire is the general appellative for any great river, like the Nile in North Africa, and the Ganges in Hindostan, and that the native name of the individual river in question is *Moienzi-enzaddi*, or the river which absorbs all other rivers.

The most important objections against the identity of the Niger and the Zaire are the supposed obstructions of the

Kong mountains, the great length of its course, which would exceed 4000 miles, the course of the Amazons, the largest known river, being only about 3500 miles, and the absence of all trace of the Mahomedan doctrines or institutions, and of the Arabic language on the coast where the Zaire empties itself into the ocean.—These are successively combated by Mr. Barrow, in the Introduction to the Narrative, we think, with considerable force and ingenuity.

In this unsatisfactory state of doubt and conjecture in which a most important geographical problem was involved, two expeditions were set on foot under the auspices of government; the one to follow up the discovery of Park by descending the stream of the Niger, the other to explore the Zaire upwards towards its source. To accomplish this object more difficulty was apprehended in the navigation than of danger from the hostility of the natives, or the unhealthiness of the climate, neither of which had opposed any obstacle to the progress of the Portuguese. It was well known both to them and the slave dealers of Liverpool, who used to frequent this river, that its navigation was impeded by a cataract at no great distance from its mouth; but that was not considered as a reason why it should not again become navigable beyond it. Maxwell's information from the slave dealers, stated it to be so, for 600 miles above the cataract. Some doubts were entertained as to the kind of vessel most suitable to be employed in exploring the river. A steam engine was suggested by Sir Joseph Banks, as being likely to assist in the navigation of the boat against the current of the river, and a boat and steam engine were constructed, but owing to some error the engine did not succeed in working the boat, and the plan was abandoned; double boats of different sizes and built of light materials were furnished, to be used in the event of meeting with shallows or cataracts, of the existence of which no doubt could be entertained.

Captain Tuckey, known as the author of a work, under the title of "Maritime Geography and Statisics," was appointed to the command of this expedition, Mr. Professor Smith, the botanist, Mr. Tudor, the comparative anatomist, and Mr. Cranch,

the collector of objects of natural history. Our readers are well aware of the disastrous fate which attended this unfortunate expedition. Captain Tuckey, Lieutenant Hawkey, Mr. Eyre, and ten of the crew, Professor Smith, Mr. Cranch, Mr. Tudor, and Mr. Galwey, in all eighteen persons died, in the short space of less than three months which they remained in the river, or within a few days after leaving it. Fourteen of the above mentioned were of the party of thirty who set out on the land journey beyond the cataracts; the other were attacked four on board the Congo (the name of their vessel in which the expedition sailed) two died in the passage out, and the serjeant of marines at the hospital at Bahia, making the total number of the deaths amount to 21.

This great mortality is the more extraordinary, as it appears from Captain Tuckey's Journal, that nothing could be finer than the climate, the thermometer never descending lower than 60° of Fahrenheit during the night, and seldom exceeding 76° in the day time; the atmosphere remarkably dry; scarcely a shower falling during the whole of the journey; and the sun sometimes for three or four days not shewing itself sufficiently clear to enable them to get an observation.

It appears indeed from the report of Mr. M'Kerrow, the surgeon of the Congo, that though the greater number were carried off by a most violent fever of the remittent type, some of them appeared to have no other ailment than that which had been caused by extreme fatigue, and actually to have died from exhaustion. The greater number, however, of the whole crew caught the fever, and some of them died of it who had been left on board the Congo below the cararacts.

The Journals of Captain Tuckey and Professor Smith have been published just in the state in which they were written; a few general observations have also been collected from their papers and those of the other officers, and added by Mr. Barrow. The Appendix contains some papers on the objects of natural history, collected by the naturalists of the expedition. The observation, by Mr. Brown, on Professor Smith's

collection of Plants,* form, in our opinion, the the most important and valuable part of the work; that containing the account of the Minerals, by Mr. Koenig, is very meagre.

The expedition reached Cape Padron on the 6th of July—the accounts of the Zaire were observed to be much over-rated; at Fathomless Point, the true mouth of the river, the velocity of the stream was about 4½ miles an hour, and the breadth of the river about 3 miles.

The Congo vessel went as high up as Embomma, where she was left at anchor, and on the 5th of August, Captain Tuckey and a party proceeded up the river in the double boats; they proceeded till the 14th, when they were obstructed by a place named Yellala, or the cataracts—here he left the boats moored, and from hence, on the 26th, a party set off on foot to explore the river. They continued onwards amidst great difficulties till the 9th of September, about 280 miles from Cape Padron, when Captain Tuckey unwillingly turned back and rejoined the Congo: in their march along the banks of the river, they experienced no hostility from the natives, although there was great difficulty in procuring provisions, and the population was very scanty.

From the account of this expedition, it now appears that the Congo falls short in some respects of the magnificent cha-

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* Mr. Brown observes, the whole number of perfect species in the Collection is about 590; of these, 250 are absolutely new: nearly an equal number exist also in different parts of the west coast of equinoctial Africa, and not in other countries; of which, however, the greater part are yet unpublished; and about 70 are common to other intratropical regions.

Of unpublished genera, there are 32 in the collection; twelve of which are absolutely new, and three, though observed in other parts of this coast of equinoctial Africa, had not been found before in a state sufficiently perfect, to ascertain their structure; ten belong to different parts of the same tract of coast; and seven are common to other countries.

No natural order, absolutely new, exists in the herbarium; nor has any family been found peculiar to equinoctial Africa.

racter given of the lower parts of its course, both in size and respecting its velocity, and resistance of the tide. About 140 miles from Point Padron the width of the river becomes narrow, and is from 3 to 500 yards broad, and continues so to Inga, about 40 miles up, the banks between which the water is hemmed in are, for the whole of this distance, every where precipitous, and composed entirely of masses of slate, which, in several places, run in ledges across from one bank to the other, forming rapids or cataracts, which the natives distinguish by the name of Yellala. The lowest and most formidable of these barriers, was found to be a descending bed of mica slate, whose fall was about 30 feet perpendicular, in a slope of 300 yards. Though in this low state of the river it was scarcely deserving the name of a cataract, it was stated by the natives to make a tremendous noise in the rainy season, and to throw into the air large volumes of white foam; but beyond this again, the river was found to expand to the width of 2, 3, and even more than 4 miles, and to flow with a current of 2 or 3 miles an hour; and near the place where Capt. Tuckey was compelled to abandon the farther prosecution of the journey, (which was about 100 miles beyond Inga, or 280 miles from Cape Padron) it is stated the river put on a majestic appearance, that the scenery was beautiful, and not inferior to that of the banks of the Thames; and the natives of this part all agreed in stating that they know of no impediment to the continued navigation of the river; that the only obstruction in the north-eastern branch was a single ledge of rocks forming a kind of rapid, over which, however, canoes were able to pass.

The opinion which existed before the expedition, that the Zaire was in a state of constant flood, or continued to be swelled more or less by freshes during the whole year, has been completely refuted by the present expedition; but Mr. Barrow conceives, that the argument which was founded on this supposition, of its origin being in northern Africa, so far from being weakened, has acquired additional strength from the correction of the error.

Mr. Barrow's proposition is, that the Niger connects itself

with the Zaire, by means of the lakes of Wangara. We have not space to follow his arguments on this head, which we think are urged with great ingenuity: but perhaps the whole style of the book, as far as regards the labour of the Editor, is a little too polemical, and more resembling that we have been used to observe in a popular Journal, than what would have been expected from the Secretary of the Admiralty, in his official capacity. We shall close our very imperfect account, by observing that Mr. Burrow is supported in his theory, by a note in Capt. Tucky's Journal, nearly the last he made, in which hs says, "extraordinary *quiet* rise of the river shews it to issue from some lake, which had received almost the whole of its waters from the north of the line." And after this, in the same Journal, the words "hypothesis confirmed," occurs; and in a private letter written at Yellala, he dwells more particularly on this proposition.

Art. XVIII. *Remarks on Dr.* Ure's "*Experiments to determine the Constitution of Liquid Nitric Acid,*"* *&c.* *By* Richard Phillips, *Esq. F. L. S. & M. Geol. Soc.*

Dr. Ure has asserted, in his observations upon the composition of nitric acid, that "the exact proportion of its two constituents, azote and oxygen, is a problem which seems hitherto to have baffled the best directed efforts of modern science. M. Gay Lussac states, as its composition in 100 parts, 30.4 azote + 69.6 oxygen; and Mr. Dalton 26.7 azote + 73.3 oxygen. Thus discordant are the latest determinations." To which Dr. Ure adds, "I hope soon to be able to present to the public some researches, which may possibly tend to clear up this mystery."

I propose to examine the accuracy of Dr. Ure's opinion on this subject, by collecting and comparing the statements which have been recently made with respect to the acid in question, by philosophers of the highest reputation. The first to whom I shall refer, is Sir H. Davy, who observes in p. 265 of his

* Journal of Science and the Arts, vol. iv. p. 291.

Elements of Chemical Philosophy, " 101 will be the number for the acid contained in the pale acid, and in the salts called nitrates, and it will consist of one [proportion] of azote, and five [proportions] of oxygene." Now as Sir H. Davy represents a proportion of azote by 26, and one of oxygen by 15, nitric acid must be composed of

25.742	azote
74.258	oxygen
100.000	

The evidence which I shall next adduce as to the composition of nitric acid, is that stated by Dr. Wollaston, in his memoir on Chemical Equivalents. Alluding to some experiments which he had just described, Dr. Wollaston says, " I have no hesitation in prefering the estimate to be obtained from Richter's analysis of nitrate of potash, which gives 67,45, from which if we subtract one portion of azote 17,54, there remain 49.91, so nearly 5 portions of oxygen; that I consider the truth to be 17.54 [azote] + 50 [oxygen], or 67.54." If then 67.54 of nitric acid contain 17.54 of azote, 100 parts must consist of

25.97	azote
74.03	oxygen
100.00	

To these determinations I shall add that of M. Gay Lussac, who is indeed quoted by Dr. Ure, to prove that discordance, rather than agreement exists on this subject; if, however, Dr. Ure had extended his researches for evidence sufficiently, he would have seen that this profound chemist, with candour worthy of imitation, has acknowledged the inaccuracy of that analysis, which Dr. Ure erroneously supposes to be, and quotes as, the result of his latest experiments.

In the Annales de Chimie et de Physique, (tome i. p. 404.) M. Gay Lussac states nitric acid to be composed of 100 volumes of azote + 250 of oxygen; we have then merely to ascertain

the comparative densities of these gases to determine their relative weights. According to Biot and Arago, equal volumes of azote and oxygen are to each other in weight as 0.96913 to 1.10359; therefore a compound of 100 volumes of azote and 250 of oxygen consists of

25.995	azote.
74.005	
100.000	

These numbers, it will be observed, are nearly identical with those which I have copied from Dr. Wollaston's memoir; they differ immaterially from those given by Sir H. Davy, and do not vary much from Mr. Dalton's analysis, as quoted by Dr. Ure.

Considering all who have preceded him in this inquiry, as having failed in the accomplishment of their intention, Dr. Ure appears to be very naturally anxious to supply the deficiency he has discovered. It would seem indeed, as if he had completed the investigation with no ordinary degree of celerity, considering the acknowledged difficulty of the subject; for when alluding in a subsequent part of his paper, to the composition of liquid nitric acid, he says, "when we inquire more minutely into the peculiarity attending the above compound of greatest density, we shall find it to consist of 7 atoms of water = 79.24, united to 1 atom of dry acid = 67.5."

It is scarcely necessary to observe, that the number representing a compound body, cannot be ascertained without a previous knowledge of the proportions of its constituents; and it must be allowed, that Dr. Ure would not represent nitric acid by a number which he knew to be inaccurate; but having denied the correctness of every previous analysis, we are at liberty to conjecture that 67.5, as above quoted, result from the performance of those experiments, before the close of his paper, which he appears only to have contemplated at its commencement. But supposing this to be the case, it is very remarkable that Dr. Ure should not have allowed, that 67.5

is almost precisely the number by which nitric acid is represented on Dr. Wollaston's scale, for he is acquainted with this instrument, and even quotes it on another occasion to prove its inaccuracy: in the present instance, therefore, it would have been but candid to have excepted Dr. Wollaston from those whose efforts have been "baffled."

The principal intention of Dr. Ure in the paper now under consideration, is to determine the constitution of liquid nitric acid, a subject which he describes as "involved in perhaps still greater obscurity and contradictioh," than that of the dry acid. To prove the justness of this observation, Dr. Ure quotes and compares the statements of Sir H. Davy, Kirwan, Dalton, and Dr. Wollaston, and he concludes them all to be erroneous.

According to Dr. Ure, 41.7 of carbonate of potash, consisting of 13.094 of carbonic acid + 28.606 potash, require 32.394 of dry nitric acid for their decomposition, and the nitrate of potash resulting weighs 61 grains: this determination agrees very nearly with Dr. Wollaston's scale, by which it appears that 41.7 of carbonate of potash, consisting of 13.26 carbonic acid + 28.44 potash are decomposed and converted into 60.94 nitrate of potash, by 03.5 of dry nitric acid; and as Dr. Ure considers that 32.394 of dry nitric acid are equivalent to 40.64 of liquid acid of sp. gr. 1.5, this acid must consist in 100 parts of

79.71 dry acid,
20.29 water.

100.00

By Dr. Wollaston's scale, liquid nitric acid of sp. gr. 1.5 is constituted of 67.54 one atom of dry acid, + 22.64, or two atoms of water, 100 parts must therefore consist of

74.895 dry acid,
25.105 water.

100.000

It appears then that whilst the composition of nitrate of potash is nearly similar according to these statements, in Dr.

Wollaston's estimate the dry acid in liquid acid of sp. gr. 1.5 is to that of Dr. Ure, as 74.895 to 79.71.

Before I mention the experiments which I have made on this subject, I shall notice and compare Dr. Ure's statements with each other. I have already quoted a passage, in which he represents acid of a certain density, as consisting of 7 atoms, water 79.24 united to one atom of dry acid 67.5; these numbers appear to be from Dr. Wollaston's scale, and of course they are considered as correctly representing the quantity of water and acid in question. If, however, we compare these numbers with those which are to be derived from Dr. Ure's analysis of liquid nitric acid of 1.5, it will appear that this acid is composed of 67.5, one atom acid united to 16.79 water, and consequently of one atom acid, and one atom and $\frac{547}{1132}$ of an atom of water, a conclusion, of which it may be truly stated in the language of Dr. Ure, that it "exhibits internal proofs of inconsistency and error." To examine the subject experimentally as well as theoretically, I prepared some pure nitric acid, which had a sp. gr. of 1.496, so nearly 1.5, that they may be considered as identical in experiment. Of this acid, I saturated 150 grains with potash, and evaporated the solution of nitrate of potash to dryness; the salt obtained weighed 215 grs.; and according to Dr. Ure, 61 of nitre contain 32.394 of dry acid, agreeing very nearly with 32.5, which is Dr. Wollaston's proportion, as then 61 give 32.5, 215 must contain 114.55 of dry acid derived from 150 of liquid. One hundred parts of the liquid acid appear to be composed of

76.367	acid
23.633	water
700.000.	

The dry acid it will be seen exceeds Dr. Wollaston's estimate by 1,472, and is less than Dr. Ure's by 3.343.

It is easier, for obvious reasons, to obtain more accurate results with carbonate of lime than with carbonate of potash; I shall therefore now state the experiments which I have made with this substance. I ascertained some years since, that 476 grains of carbonate of lime require 681.75 of liquid nitric acid,

sp. gr. 1.5, for their decomposition, and this determination has been noticed by Dr. Wollaston, as agreeing very closely with his views of the composition of liquid nitric acid. In order to try how much nitrate of lime would be obtained from the decomposition of a given weight of the carbonate, I put 150 grains of double refracting spar into a quantity of nitric acid insufficient to decompose the whole of it; the platina crucible containing the solution of nitrate of lime, and the undecomposed carbonate, was heated till all the water was dissipated; on weighing, I obtained 243.2 grains. After dissolving the nitrate of lime in water, I found 3.4 of carbonate unacted upon; if then we subtract 3.4 from 150, the quantity of carbonate of lime originally used, and also from 243,2 the weight of the nitrate and carbonate of lime, it will appear that 146.6 of carbonate, were converted into 239.8 of nitrate of lime.

The experiments which I have now mentioned, show that 63 of carbonate of lime are decomposable by 90.23 of nitric acid 1.5, and that 103.05 of nitrate of lime result from their action, it will be seen by the scale, that 63 of carbonate of lime contain 35.46 of lime, which deducted from 103.05 the nitrate of lime give 67.59, as the dry nitric acid contained in 90.23 of liquid acid of 1,5, or it consists of 74.91 acid + 25.09 water, a determination in which it will be seen, that the acid differs only about $\frac{1}{5000}$ part from the quantity stated by Dr. Wollaston.

With respect then to the composition of liquid, as well as of dry nitric acid, I conclude in direct opposition to Dr. Ure, that the subject is neither obscure nor mysterious; on the contrary, it appears to me, that the eminent philosophers, whose results he quotes to condemn, or whose conclusions he confirms or copies, have effected all the certainty which can be derived, from the "best directed efforts of modern science."

Art. XIX. *Proceedings of the Royal Society of London.*

Thursday, Jan. 8*th, and* 15*th.* These meetings of the Society were occupied by the reading of a paper presented by Dr. Brewster, relating to the laws of double refraction in regularly crystallized bodies.

Jan. 22. A paper was communicated by Sir Everard Home, containing additional facts respecting certain fossil remains, formerly described by the author in the Philosophical Transactions. The analogy between the animal alluded to and cartilaginous fishes, is destroyed by the examination of the bones of the sternum, which much resemble those of the Ornithorynchus Paradoxus. Sir Everard proved that the fossil animal lived in water by the form of its vertebræ; while from the shape of its chest it was shewn to have breathed air. In concluding his observations upon these subjects, Sir Everard remarked upon the interest of discovering in this country fossil bones which bear an analogy to those of an animal of New Holland of so peculiar a character as the Ornithorynchus

Jan. 29. An extremely curious and important paper was read to the Society by Captain Kater, giving an account of his experiments for determining the length of the pendulum vibrating seconds in the latitude of London. We have already hinted that the President and Council adjudged the Copley Medal to Captain Kater for this important inquiry; after shewing the objections to all methods hitherto practised for accurately ascertaining the length of the seconds pendulum, Captain Kater detailed with great perspicuity the mode of proceeding which he had successfully adopted, and which was founded on the reciprocity of the centres of suspension and oscillation. Captain Kater then describes the various corrections for temperature, pressure, and height above the sea, and having shewn the advantages of his different methods, concludes, that the length of the pendulum vibrating seconds in vacuo at the level of the sea, measured at the temperature of 62° Fahr. and the latitude of

the place of observation deduced from the data contained in the Trigonometrical Survey, being 51° 31′ 8″4 North, is,

By Sir George Shuckburgh's Standard, = 39,13860 inches.
By General Roy's Scale, - = 39.13717 do.
By Bird's Parliamentary Standard, = 39,13843. do.

Feb. 5th. Captain Kater communicated a paper on the length of the French metre, estimated in parts of the English standard. —For the purpose of ascertaining this important point, two metres were sent from Paris—the one is a bar of platinum of the exact length, and called the *metrè à bouts*—the other is a somewhat longer bar of the same metal upon which the length of the metre is shewn by two very fine lines—it is called a *metre à traits.* The mean result of several very delicate experiments gave the length of the French metre = 39,37071 inches of Sir George Shuckburgh's scale—or 39,37062 inches of Bird's Parliamentary standard.

At the same meeting a paper was read by Thomas Andrew Knight, Esq. on the office of the heart-wood of trees. Mr. Knight's object in this paper was to shew that the heart-wood of trees is a winter reservoir for the organizable matter required for their germination in the spring, and that the presence or absence of this reservoir is connected with the annual, biennial, and perennial duration of plants. The annual having no such reservoir, is entirely exhausted in forming its flowers and seeds. A biennial fills its reservoir one season, and exhausts it the next, and in the tree, part of the sap descends to form roots, and part ascends to produce buds, and it also forms a new annual layer of bark. Mr. Knight's paper also contained some statical experiments on the quantity of water contained in the alburnum of different trees, at different seasons of the year.

Feb. 12. A paper by Dr. Marshall Hall was read on the combined agencies of oxygen and water in producing the oxidizement of iron. Dr. Hall has shewn in this paper, that iron is incapable of decomposing water at common temperatures, and that it becomes rusty or oxidized when exposed to common water, as is generally stated; but from the decomposition of the

air in water—he also shews that nitrogen alone is evolved and no hydrogen; and that when water is deprived of atmospheric air, or oxygen, iron retains a clear and bright surface though exposed for many months to its action.

At the same meeting Sir H. Davy read some remarks on the fallacy of the experiments, in which water is said to have been formed by the decomposition of chlorine.

These experiments go to prove that the oxygen required to form the water obtained in the experiment alluded to, is derived, not as has erroneously been asserted, from the *chlorine*, but from other sources, which had eluded the vigilance of the experimentalists.

Feb. 19th. A letter from George Rennie, Esq. to Dr. Young, was read, containing an account of some experiments on the strength of materials. Mr. Rennie shews in this communication, that the strength of cast iron is extremely various according to the circumstances under which it has been cast.—Thus, vertical castings are stronger than horizontal, &c. Observations are annexed on the relative strength of woods, stones, and other building materials.

Feb. 26th. A paper was presented by Thomas Knight, Esq. containing a solution of an analytical problem; and another by J. F. W. Herschell, Esq., "on circulating functions, and on the integrations of a class of equations of finite differences into which they enter as coefficients."

Mar. 5. A paper was read to the Society on the Parallax of certain fixed stars, by the Rev. John Brinkley, D. D. F. R. S.; and at the same meeting, Sir Everard Home communicated some additions to his Croonian Lecture. (See page 362, Vol. 4, of this Journal.) Captain Kater having put the author in possession of more accurate measurements of the globules of the blood than those formerly given, Sir Everard now stated these to the Society—and is induced to consider the diameter of a globule of the blood as $= \frac{1}{1800}$ of an inch instead of $\frac{1}{1700}$.

This paper also contains many additional experiments and observations relative to the formation of tubuli by the extrication of air during the coagulation of blood.—The author also

announces that similar appearances are obtained during the exsiccation of pus, and applies this circumstance to the explanation of the formation of granulations in sores.

Mar. 12. A letter from B. Bevan, Esq. to the President, was read, relative to the discovery of some fossils in Leicestershire and Northamptonshire; and also a letter from Dr. Fischer of Moscow, containing observations on the anatomy of spiders—with some illustrative drawings.

At this meeting, the Society proceeded to ballot for foreign members, and the following Gentlemen were announced by the President as duly elected into the Society.

Mr. Nathaniel Bowditch, of Salem, of the State of Massachussets.

Messrs. G. F. C. M. de Prony, Francis Arago, S. D. Poisson, J. P. Haüy, } of Paris.

The Society then adjourned for the Easter Vacation

Art. XX. *Proceedings of the Royal Society of Edinburgh.*

1818. *January* 5. The continuation of Dr. Murray's paper on muriatic acid gas was read. The conclusion drawn from the experiments before, and now detailed, is that chlorine is not a simple body, but the idea of its being a compound of muriatic gas and oxygene is not adopted. Dr. Murray then offered a theory in explanation not only of the nature of muriatic acid, but of acids and alkalies in general. Both oxygen and hydrogen were supposed to have the power of conferring acidity and alkalinity on the bodies with which they combine, and that when both combine at once with a body, the properties which they impress are proportionately increased. Chlorine therefore is conceived to be a compound of an unknown base with oxygen; muriatic acid a combination of chlorine with hydrogen,

or rather of the same radical with oxygen and hydrogen. Sulphurous acid is a binary compound of sulphur with oxygen and is analogous to chlorine: sulphuric acid is a ternary compound of sulphur, oxygen, and hydrogen, and is analogous to muriatic acid.

In alkalies an analogous series of combination are supposed to exist. Ammonia is in the same relation to this class of bodies, that sulphuretted hydrogen is to the acids; morphium holds the same rank among them that prussic acid does among its fellows; and the fixed alkalies and alkaline earths are considered as ternary compounds of oxygen, hydrogen, and a base like the stronger acids.

At the same meeting a paper by Dr. Brewster consisting of extracts of letters from Mr. Boag to his father the Reverend Dr. Boag of Paisley was read, giving an account of the recent discoveries respecting the sphinx and the principal pyramid of Egypt, which have been made by Capain C. and Mr. Salt.

By very laborious excavation, it has been ascertained that the sphinx is cut out of the solid rock on which it rests. At the pyramid it was found that the short descending passage from the entrance, which afterwards ascends to the two chambers, is continued in a straight line through the base of the pyramid into the rockupon which it stands. This new passage, after joining what was called the well, is continued in a horizontal direction, and terminates in a well ten feet deep, exactly beneath the apex of the pyramid, and 100 feet below its base, An apartment has been discovered immediately above the king's chamber. The ornamental part is very beautiful, but it is only four feet in height.

Jan. 19. The second part of Dr. Ure's paper on muriatic acid gas was read. It relates to the water that adheres to apparently dry muriate of ammonia, and to the experiments in which by passing dry muriatic acid gas over iron ignited, water was obtained. The Doctor infers that chlorine is oxymuriatic acid, and that muriatic acid gas is dry muriatic acid and water.

At the same meeting a paper by Dr. Brewster was read, on

a singular affection of the eye in a healthy state. When the eye is steadily directed towards an object, that object will always continue visible, but if the eye be fixed on a second object in the neighbourhood of the first, the first object will after a short time disappear, however situated, with respect to the eye, or whatever its colour or appearance. When the object produces its accidental colour before it vanishes, the accidental colour disappears with the object. In the course of an investigation into effects of this kind Dr. Brewster was induced to form a new theory of accidental colours, which will shortly be made public.

Feb. 2. Mr. W. Allan read a paper on the geology of the country around Nice, and from the circumstances detailed in the paper that part of Italy must be of extreme interest to the inquirer. There are many indications that great changes have taken place in this country, not only in the situation of the rock and strata, but even in the height of the land and waters. The cracks and fissures in the rocks are frequently found to contain shells similar to those which now exist in the Mediterranean, and they are found also high up among the alluvial soil, and down by the sea from the Harmetine countries. More than twenty new species of shells have been found in the strata of the peninsula of St. Beassure.

Mr. Playfair communicated a paper by General Sir Thomas Brisbane, on the determination of time by equal altitudes.

Feb. 16. Mr. Macvey Napier read a paper entitled *Remarks illustrative of the Scope and Influence of the Philosophical Writings of Lord Bacon.*

Mr. Napier stated that his object was two-fold; first, to show, that Bacon's philosophical merits were such as to give him a peculiar and pre-eminent character among the early restorers of genuine science; and next, to trace the effects which his writings produced in accelerating the progress of scientific discovery. The consideration of the latter point would form, he said, his principal object; as there seemed to exist more of doubt, as well as of misapprehension, in regard to the

influence of Bacon's writings, than in regard to any other point connected with them.

Under the *first* head, he took occasion to comment upon a late depreciatory estimate of Bacon's Philosophical Writings published in the *Quarterly Review;* and then proceeded to some general remarks illustrative of their peculiar merits and importance. Under the *second* head, he entered into a variety of statements, and cited a variety of early authorities, to prove that Bacon's writings contributed more than any other cause to forward the progress of science in England, and to form that great experimental school which produced the discoveries of Boyle and Newton. In this part of the inquiry he endeavoured to show, that the first idea of the *Royal Society* was suggested by Bacon's writings, and not, as some have supposed, by the institution of scientific academies abroad. In the last place, he proceeded to inquire, whether any similar effects to those produced by these writings in England had been produced by them in other countries? He here quoted a number of foreign publications to show, that Bacon's writings had early made an impression abroad greatly favourable to the progress of truth, and that beneficial effects were largely ascribed to them by many early writers who witnessed their operation.

March 2d. Dr. Murray read the first part of a Paper, "On the Relation in the Law of Definite Proportions in Chemical Combination, the Constitution of the Acids, Alkalis, and Earths, and their Compounds." Its object was to determine if the composition of these substances, according to the theory which he has lately proposed, be conformable to the law of definite proportions. The part of the Paper read extended to the acids, of which sulphur and carbon are the radicals, the vegetable acids being comprised under the latter. A very strict coincidence is found in the actual proportions according to the theory, with the law, so as to afford proofs even of the truth of the former; and some of the results display views very different from those which have been hitherto proposed.

The remainder of the paper will be read on a succeeding evening.

At the same meeting, an abstract of a new paper, by Mr. Lauder Dick, on the Parallel Roads of Lochaber, was read. Upon considering the paper which he had prepared on the Parallel Roads of Lochaber since his second visit to that district, he was satisfied that it would not be very intelligible if read to the Society, owing to the frequent references to the map and drawings. He therefore contented himself with a very few remarks explanatory of the views he entertained of this interesting subject.

In a former paper, he described the general nature of these shelves. He has since ascertained, by several observations, that they are perfectly horizontal. One very remarkable circumstance attending them is, that in one or two instances they can be traced in a perfect circle, around little isolated hills, on a level with the corresponding line on the sides of the valley.

In his former visit to Glen Roy, he traced the shelves in that valley only; on the late occasion, however, he discovered that they are also to be found in Glen Spean and Glen Gluoy. This last valley contains one range, at an elevation of 12 feet higher than that of any of those in the other glens. The two shelves next in altitude, are to be found in Glen Roy alone. The uppermost runs through both lower and upper Glen Roy, and loses itself in the flat mossy ground, forming the summit level of the country near the Loch of Spey. Besides these two shelves, which are the particular property of Glen Roy, there is another at a lower level, common to Glen Roy and Glen Spean. Its two extremities are to be traced—one on the mountain of Ben-y-vaan, near High-bridge—and the other on the side of Aenachmore, one of the Ben Nevis groups, nearly opposite. This shelf may be followed almost every where in its progress through both glens. It runs up the whole extent of Glen Spean, Loch Laggan, and the river Pattaig, as far as the Pass of Muckull, where it sweeps round on what is the summit level of the country there, and returns back. It is also distinctly traced running into the valley of Loch Treig.

In the paper formerly read to the Society, Mr. Lauder Dick stated it as his opinion, that such appearances in general were to be attributed to the operation of the waters of a lake. His last inspection of those in Lochaber has not only confirmed his conviction of the truth of this theory, with respect to them, but has led him to imagine that he has discovered the boundaries, extent, and shape of the ancient lakes, as well as the cause which produced their evacuation. He conceives that he is warranted to conclude from the observations he has made, that Glen Gluoy was at one time an independent lake, having its level twelve feet above the lake of Roy, when at its highest, into which it discharged a stream from its N. E. extremity. Glen Roy must have contained an independent lake in two different states, as indicated by its uppermost and second shelves. Whilst in the first state, its level must have been such, that it discharged its waters, and those tributary to it from Loch Gluoy, in the direction of the Loch of Spey, and by it towards the eastern sea. When this was the case, a barrier must have existed at the mouth of Glen Roy, separating its lake from one at that time occupying the whole valley of the Spean, at the level of the lowest shelf of all,—and which has such a relation to the summit level at the Pass of Muckull as to warrant the conclusion, that it must have sent its stream through it towards the eastern sea, by the course of the river Spey. Two different ruptures took place in the barrier of division between Lochs Roy and Spean. The first, diminished the surface of Loch Roy so much, as to render it tributary to Loch Spean:—The second breach reduced it to the level of Loch Spean, of which it now formed a portion. Whilst the lakes were in this state, Mr. Lauder Dick supposes that the whole ground at their south-western end was one unbroken mass, and that the great glen of Scotland had then no existence, and consequently, that what are now the mouths of Glen Gluoy and Glen Spean were shut in by a terra firma, and that the united waters of the whole lakes formed a river, running through the Pass of Muckull, towards the eastern sea.

An examination of the Glen-mor-na-albin, or Great Glen of Scotland, stretching in a diagonal line across the island from Inverness to Fort William, has convinced me, that it has owed its origin to some convulsion of nature, and that the opening of this vast chasm, was the cause of the discharge of the water of the lakes, and of the change of the direction of the current of the rivers, which now run to the western, instead of to the eastern sea, as they seem to have done formerly. He conceives also, that the horizontal shelves of Lochaber, and this vast crack across the island, reflect a mutual light on each other, elucidating the history of both.

March 16*th*. Professor Leslie read an account of his new instrument called the Ætherioscope; but as a full description has already been published, it is unnecessary to give any abstract of his paper at present.

At the same meeting, Dr. Brewster communicated to the Society a paper on a new theory of Double Refraction.

Art. XXI. *On Street Illumination.* *By* John Millington, *Esq.*

At a time when the lighting up of our streets is so much improved by the almost general adoption of coal gas, any observations on this head may be deemed superfluous; but the possession of a good light, affords no reason for the waste of it, which constantly occurs from the dark colour, and light absorbing nature of the covers which are at present made use of for street lamps. It was not a little amusing, before the present general introduction of gas lights, to observe the various expedients which were resorted to in the streets of London, to augment the scanty pittance of light which was allowed to the inhabitants by the penurious contractors for the supply of oil; and the confines of each parish could be clearly ascertained by its bull's eye lenses, dazzling the eyes of the passenger at every

thirty yards, and then leaving him in almost total darkness; or by the various contorted reflectors twisted into almost every shape which imagination could suggest, though in most cases without enough of optical knowledge to know what their effect would be until tried for a season, when they were most frequently laid by to give way to new forms equally inefficacious. These were in a great measure rendered nugatory by the very excellent and ingenious lamp of Lord Cochrane, for which he obtained a patent, but which was afterwards set aside by the decision of a court of law. These lamps have been for some time used in the parish of St. Anne, Soho, and St. John the Baptist, Savoy Precinct, and are decidedly the best street lamps for oil which are at present in use. Their principle depends upon constantly admitting a current of atmospheric air to play upon the burner through a tube, instead of inclosing the flame in a glass vase, having but one common opening at the top for the passage of the smoke outwards, and the entry of that air which is necessary to support combustion; and by covering the whole opening of the glass vase with a concave reflector of planished tin placed above the flame, which reflects all that light downwards which in all other cases is lost. The flame of these lamps is made rather larger than usual, which of course implies a greater consumption of oil; but in this his Lordship was guided by true philosophical reasoning, since it was accurately ascertained by Count Rumford, that if burning 228 grains of oil in a given time produced, 100 degrees of light, as measured by his photometer, that 441 grains consumed in the same time would yield 600 degrees of light; while 560 grains produced 900 degrees: and thus a six-fold light was produced by less than a double quantity of oil; and by the further addition of little more than half the first quantity, the original light was increased in the proportion of nine to one; which prodigious increase Count Rumford accounted for * on the present generally received doctrine of flame, viz. that as the particles of which flame is

* See his Seventeenth Experimental Essay on Light.

composed are so far cooled as to be no longer red hot, they cease to be luminous, and consequently to be visible; the object in all cases of illumination, is therefore to preserve the heat of flame as long as possible, which will be accomplished by producing a larger fire from uniting the oil used in two lamps to be consumed in one wick in the same time, which by the foregoing experiments, owing to the increase of heat, will produce light in the proportion of 6 to 1. This circumstance was fully proved in St. John's parish before named, when although but half the usual number of lamps were used in the streets, at least three times as much beneficial light was produced, as by the old method.

Although the reflectors adopted by Lord Cochrane are the most efficient which I have seen for producing that equal distribution, instead of concentration, of light, which is so desirable in the streets of a town, yet they possess disadvantages which have not yet been overcome. They, in common with all the other reflectors I have seen, are made of planished or hammered tin, and so polished, that when new, they reflect a tolerably perfect image of the flame; but although tin, from its cheapness, is perhaps the best metal which can be used, still, notwithstanding they are better protected from smoke in Lord Cochrane's lamps than in many others, they are liable to oxidation or tarnish, by which they become inefficient; nor can they be expected to be kept in proper order by the parties to whose care they are entrusted, their numbers being great, and the time for attending to them very limited; besides which, tin, from being thin, is liable to bruises and loss of its proper figure, and as it consists merely of iron plates thinly coated with the soft metal tin, this soon wears away by cleaning, when all power of reflection is lost. Besides this, a perfect reflecting surface is not necessary, nor indeed so good, in a street lamp, as one which, from not absorbing the light, throws it downwards without producing a focus or concentration of light sufficient to dazzle the eyes of the passengers. My attention being drawn to this subject about ten years ago, I was induced to try a number of experiments upon the powers

of different reflecting substances, and I found none of them so efficient for throwing down a plentiful and equally diffused light as the common glazed white earthen ware, of which dinner plates and dishes are usually made, and of which any one may convince themselves by simply holding a white plate in an inverted direction over a lighted lamp or candle. I proposed that flat circular plates or reflectors of this material should be made of a diameter equal to that of the opening of the glass vase containing the lamp, or the tin cover which is placed upon it, and that a hole of about two inches diameter should be left in the middle of the plate or reflector, or directly over the flame, wherever it might be, for the escape of the smoke, so that a plan of the reflector would appear like fig. 1, and a section through the middle of it like fig. 2, which also shews the situation of the flame.

Fig. 1.

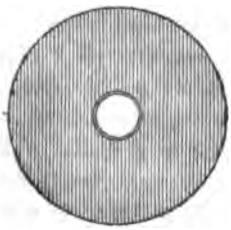
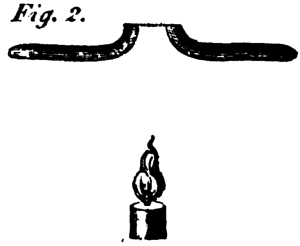


Fig. 2.



Upon mentioning this to some of the leading parties in a London parish, the only objections which were made were, the fragile nature of the material, and its liability to become smoked, and lose its reflecting power; and I was requested to make some trials on these points, which I have since done, though I have never till now thought of making them public. The result was, that if a lamp is properly trimmed and adjusted, (i. e. the wick not placed too high, which never is the case with the street lamps which are contracted for), no detrimental quantity of smoke is deposited in two or three nights burning, and when it does accumulate, it is instantly removed by a bit of tow or rag, with much less trouble than is necessary to keep tin reflectors in order. These reflectors may be

very conveniently fixed within the cover of the lamp so as to remove with it, by three or four bits of tin or wire soldered to it, and bent over the edge of the reflector, so that it has no chance of being broken except by a fall of the cover; and I find upon enquiry, that if such reflectors are obtained in a wholesale manner from the Staffordshire potteries, they can be furnished at from three halfpence to twopence each. The flat under surface of fig. 2, will, I think, be the best for general use, but if a greater dispersion of light should be desirable, a reflector, of which fig. 4, is a central section, may be adopted, and on the contrary, where a concentration of light is wanted, as over door-ways, the concave form of fig. 3. the under surface of which is a portion of a hollow sphere, may be used.

Fig. 3.

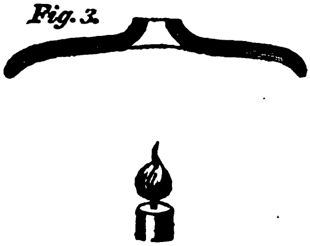
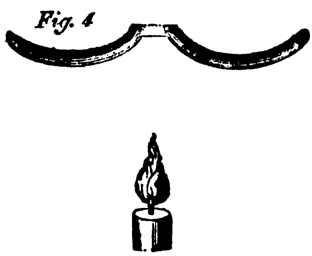


Fig. 4



Any of these reflectors, it will be seen, are applicable to Lord Cochrane's construction of an oil lamp; and since the general introduction of gas, which has in a great measure removed the objection of their becoming smoked, I think they will be found of utility to the public in all cases where light is to be cast downwards by reflection. Where the obstruction of an opake reflector would be detrimental, and it is desirable to diffuse light in all directions, and at the same time to concentrate it on one particular object, or in one line, the use of a hollow cone of polished metal or earthenware, like a speaking trumpet, and having a similar opening at its apex, to the exterior of which the flame is to be applied, will be found very advantageous.

Art. XXI. *Expedition to the Polar Seas.*

The expedition, consisting of four ships, destined to make discoveries in the polar regions, is to leave the Thames in a few days: two of the ships are to proceed northerly into what has been termed the polar basin, and to endeavour, by passing close to the pole, to make a direct course to Behring's Strait; the other to push through Davis' Strait for the north-east coast of America, and to proceed to the westward, with the view of passing Behring's Strait. The article on the subject of the North-west Passage in the last Number of the Quarterly Review, has displayed so completely all that can be said in favour of the probable issue of these expeditions, and also has detailed the different facts which have lately been noticed respecting the changes in the arctic regions, that we shall conceive it best to consult the advantage of our general readers by not entering into any details on this subject; but there is one point which we think it important to notice, because it should seem, that the writer of the article in question has either treated too lightly the authority of foreign geographers, or was not acquainted with all the facts stated by M. Malte le Brun, in his Histoire de la Géographie, 392, or the authorities referred to by him.

We allude to the disputed point of the former existence of a colony on the *east* side of Greenland. In the Review above noticed, it is stated,—"It is generally admitted, that for the "last four hundred years, an extensive portion of the eastern "coast of Old Greenland has been shut up by an impenetrable "barrier of ice, and, with it the ill-fated Norwegian or Danish "colonies, who were thus cut off at once from all communi-"cation with the mother country—that various attempts have "been made from time to time to approach this coast, with "the view of ascertaining the fate of the unfortunate colonists, "but in vain; the ice being every where impervious; and "that all hope being at length abandoned, that part of this "extensive tract of land which faces the east took the appro-"priate name of lost Greenland.

"A central ridge of lofty mountains, covered with perpe-
"tual snow, and stretching from south to north, divides Old
"Greenland into two distinct parts, called, by the ancient
"Norwegian and Danish colonists, the East Bygd and West
"Bygd; between which all communication is totally cut off
"by land, and by sea also, since the fixing of the icy barrier.
"The colony on the west side increased to four parishes, con-
"taining 100 villages; but being engaged in perpetual hostility
"with the Esquimaux, the whole were ultimately destroyed by
"them. The Danish colony on the eastern was still more ex-
"tensive than that on the western side. The country was
"named Greenland from its superior verdure to Iceland."

The writer then, after enumerating the different attempts which were made by the Danes to find this supposed lost colony, observes,—"after so many attempts, both public and
"private, how the Danes can now pretend to doubt, as one of
"their writers affects to do, whether there ever was a colony
"on the eastern side, is to us quite inexplicable, unless it be to
"palliate their negligence at the first approach of the ice, and
"their want of humanity since. The Danish government,
"however, entertained no such doubts; for so late as the
"year 1786, Captain Lowenore, of the Danish navy, was
"sent out for the express purpose of re-discovering the old
"colony on the eastern coast, but he was unsuccessful.

"It has fallen to the lot of the present age to have an oppor-
"tunity, which we are sure will not be neglected, of instituting
"an inquiry into the fate of these unfortunate colonies. If,
"as is most probable, the whole race has perished, some re-
"mains may yet be found, some vestiges be traced which may
"throw light on their condition after the fatal closing of the
"ice upon them."

In opposition to this, we lay before our readers the following extracts from M. Malte-Brun's History of Geography.

"The number of colonists of Greenland were inconsider-
"able, not above a third of one large parish of Norway; and
"a Bishop was put over them, by reason of their distance
"from the mother country. The Scandinavian colonies in

" Greenland were divided into two districts, the *western*, which
" had but four churches; the other *eastern*, where the remains
" of two towns, or rather hamlets were found. This fact of
" the division into eastern and western," observes M. Makte-Brun, " has given rise to a material error in geography; it being
" supposed that the eastern colony was on that part of Green-
" land *opposite* to Iceland.*

" And all the descriptions of East Greenland were applied
" to these coasts opposite Iceland, which were in fact unknown;
" and imaginary bays and promontories, &c. were created and
" named. This mistake originated in Torfeus, and other Ice-
" landic authors, but a modern writer has cleared up this point.†

" In examining the relations of the first navigators, it
" appears that on quitting Iceland to make Greenland, they
" steered to the S. W. avoided a coast surrounded by ice,
" doubled the point called Hvarf, and then made to the
" N. W. in order to reach the colony.† In quitting Ber-
" gen, in Norway, to make the same point of Hvarf, they
" steered straight to the west, and passing in sight of the
" Shetland and Ferroe islands, saw birds arriving from
" Iceland. On tracing these two routes on a chart, one is
" persuaded that Cape Hvarf is the southern extremity of
" Greenland, and consequently old eastern Greenland must
" only have consisted of the most eastern and most western
" portion of the western coast. In fact, it is only during the
" month of June that a fine verdure justifies the name of
" *Green*land, which the Icelanders gave to this country.

" Finally, the ruins of the ancient villages and the churches
" completely sets this point at rest. Several were found on
" the south-west coast, and there been have found as many as
" seven churches; and more ruins were found to the north of
" Cape Desolation, none being observed in the intermediate
" space: and these two series of ruins shew, without contra-
" diction, the site of the two colonies."

* Arngrim Jonæ Specimen Island: II. 146. Torfeus, &c.

† Engers on the true situation of Eastern Greenland, in the Memoirs of the Œcomonic Society at Copenhagen.

With respect to the success of the expedition, we are not so sanguine as the author of the Review, nor do we consider the article quoted, as having treated the subject with impartiality; at least it appears to us, that many probable obstacles have been left unnoticed, and that there are many objections to the theory stated, which have not been fairly met, and which we shall notice more at length in our next. That there are many circumstances which lead to the supposition of a North-west passage cannot be questioned, though the facts stated relating to the currents &c. might be accounted for on different grounds; and the harpoons found in the Pacific may have first been obtained by the Esquimaux from the Dutch, and been carried across the Continent of America. Neither is there any conclusive reasoning produced to shew that vast bodies of ice may not be formed in the open sea, as suggested by Mr. Scoresby: and at the South Pole, where there is a still greater collection of ice, no land had yet been discovered; that the shape and quantity of ice in these seas is at all times varying, is unquestionable, and of late very considerable variations have been observed; but it is not probable that any real change affecting the whole nature of these regions, or essentially altering their character, has taken place. From all that we can collect, it seems that the greater number of ships which have frequented these seas have been, on reaching the high latitudes, beset by ice, as happened to Lord Mulgrave, and obliged to return. Some few of the many have by an accidental change of the wind, been enabled to proceed beyond 80°, and then have not met with any obstruction to their further course; but these events have been accidental; and we cannot but think that the most probable mode by which the Pole will be reached, if it ever is, will be by some one of the whalers, who will be enabled to avail themselves of any accidental opening or favourable wind. By the Act just introduced, all obstacles to this this being done by the whale ships have been removed. Lord Cochrane, we have heard, has fitted up a steam vessel, in which he means to attempt to reach within such limits of the Pole as will entitle him to the parliamentary reward. One advantage to be derived from a steam vessel in the navigation

of these seas is, that the vessel will be able to proceed during a calm, the period at which other vessels are in the greatest danger of being beset with ice. How far the machinery of a steam vessel may be worked in seas incumbered with ice, we are unable to form an opinion.*

Art. XXIII. *On the new British Method of preparing Flax and Hemp.*

The method which has lately been introduced in England, of preparing flax and hemp by the dry process, has of late excited considerable interest, not only in this country but on the Continent, and some remarks have appeared upon it in *Les Archives Philosophiques et Litéraires,* which call for a reply.

It is there stated with truth, that Mr. Lee obtained the King's letters patent for his process, the particulars of which were kept secret by orders of Government (meaning, no doubt, by the Act of Parliament which was passed for that particular purpose); and that Messrs. Hill and Bundy have since obtained a patent for another process, affirmed to be preferable to Mr. Lee's, and that Government have also forbid its publication; so much do they believe it to be the interest of England to enjoy, exclusively, the process, the results of which are of such great importance to European industry.

It goes on to state, that the French Government, which suffers nothing to escape that can contribute to the national

* In the article we have quoted, the non-existence of land in a northerly direction in the part termed Baffin's Bay, and to the north of Behring's Straits, is nearly taken for granted; Captain Burney has maintained, (and upon grounds which are scarcely touched in the Quarterly Review), that there exists a portion of land north of Behring's Straits, and which he supposes unites Asia with America. With respect to the formation of ice in the polar seas, it will be seen from the paper of Mr. Scoresby on this subject, that he is at issue with the writer in the Quartely Review; and if the fact of the formation of ice independant of land is once admitted, all probability of the polar seas being so free of ice as to be navigable, is removed. It seems absurd to us to expect any benefit in a commercial point of view, from a diminution of the distance to China by the discovery of a northern passage, when the difficulty which must attend such a voyage is considered.

prosperity, ordered researches on this subject to be undertaken at the *Conservatoire Royal des Arts et Metiers;* and that M. Christian, the director of that establishment, although debarred from any information as to the English mode of procedure, had effected a very simple machine, consisting of rollers fluted longitudinally, and certain other apparatus, which is briefly described, and which was found to answer most perfectly the purpose for which it was intended. We therefore feel ourselves called upon to state, that the last-named patent was taken out by Mr. Bundy only, instead of Messrs. Hill and Bundy; and that this patent was enrolled in the usual way, without any Act of Parliament, interference of Government, or attempt at secrecy. On the contrary, the machinery was publicly exhibited and explained by Mr. Millington more than once, in his Lectures at the Royal Institution, before very numerous assemblies, as will appear by reference to the account of his Lectures in the last Number; and it has since been shewn and explained, both by the proprietors and by Mr. Millington, to several foreigners of distinction, and, in fact, to every person who was desirous of information on the subject. Mr. Bundy also obtained a French patent, and enrolled his drawings at Paris, very soon after the English patent was granted, for the protection of his particular and individual interest; but surely this ought not to be construed into any wish, on behalf of the English nation, to keep that to themselves which can be useful to the world at large.

We understand that the Queen has adopted the use of these machines at Frogmore with perfect satisfaction, and that by their means she keeps 40 poor persons constantly at work. This is a meritorious example, worthy to be followed by every opulent landholder; and we beg to refer our readers to the benefits likely to accrue to the nation from the encouragement of flax husbandry, as detailed in the Report and Evidence of the House of Commons, given in the present Number. The whole month of April is an advantageous time of the year for sowing flax and hemp seeds.

TO CORRESPONDENTS.

Trinity College, Cambridge, 6 *January*, 1818.

THE Editor thanks Professor Cumming for the following letter, which he communicated to Mr. Daniell, whose answer is annexed.

DEAR SIR,

IN the last Number of the Journal of the Royal Institution, there is a paper by Mr. Daniell, which however ingenious in other respects, involves an error that appears to me fatal to his hypothesis. He supposes (page 38) that because the superficies of an octohedron is double that of a tetraedron, its solid content is likewise double; and that, since in the instance he has given, there are 44 spheres in the octohedron, and only 20 in the tetraedron, the specific gravity of the former solid should be greater than that of the latter, as "containing more than double the number of particles under a double surface." I need not tell *you* that the surfaces of the solids have nothing to do with the matter, for the specific gravities of the solids will be as their *weights* directly, and their *volumes* inversely. If n be the number of spheres in the side of the equilateral triangle on which these solids are erected, the whole number of spheres in the octohedron will be to those in the tetraedron, as $\frac{n}{3}(2n^2+1)$ is to $\frac{n}{6}.(h^2+3n+2)$, which when the number of spheres is indefinitely great, becomes the ratio of 4 to 1.

The volumes of the solids are to each other in the same ratio of 4 to 1; it follows then, that their specific gravities should be equal, and that Mr. Daniell's reasoning, so far as it is founded on mathematical considerations, is radically wrong.

Were I personally acquainted with Mr. Daniell, I would have written to him; as I am not, you will, I hope, excuse my troubling you on this subject. I do this with the less reluctance, as I conclude you would wish rather to have the opportunity of correcting any mistakes that may appear in your Journal,

than to allow them to remain till they are animadverted upon in any other publication.

Believe me, dear Sir, truly yours,

J. Cumming.

Mr. Daniell is much obliged to the Editor for Professor Cumming's friendly communication. He hastens to acknowledge and correct an error into which he has very carelessly fallen, and which materially affects the latter part of his second paper on the Elementary Construction of Crystals. He would, however, still venture to suggest, that an attentive consideration of the structure of a corner of a cube, as compiled of spherical atoms, upon the octohedral arrangement, would demonstrate the *possibility* of a different elementary arrangement in different parts of the same solid, and that consequently, equal weights may not *necessarily* be included under equal volumes.

Letter from Dr. Prout to the Editor.

Sir,

I beg leave to correct an oversight in your late review of Dr. Thomson's Chemistry. In vol. 7, p. 111, of the Annals of Philosophy, you will find a second paper by me on the same subject as that you have quoted, in which several mistakes occurring in the first are corrected, and among others, one respecting ammonia. In this second paper, you will find that I agree with Dr. Thomson in considering ammonia as a compound of *one* atom of azote and *three* of hydrogen.

I beg leave also to refer you to vol. iii. p. 415, of the Royal Institution Journal, where you give an extract from a German paper, of which you appear to have thought favourably. The results there given coincide precisely with those I had long before published in the two papers above alluded to.

I am, Sir, your's, &c.

W. Prout.

8, *Southampton Street, Bloomsbury,*

23 *January*, 1818.

This communication of Dr. Prout materially strengthens our argument against hasty determinations of chemical equivalents and atoms, and sets in a striking point of view the danger of yielding to the facility of round numbers and

numerical coincidences. It appears, upon making the reference above directed, that three months had not elapsed from the period of the publication of his paper before Dr. Prout found it necessary to publish "a correction of an oversight which influences some of the numbers given in his Essay," and to direct that some of the *coincidences* and *round numbers* should be "expunged."

With respect to the oversight with which we are charged, we are not accountable for it; we merely referred to Dr. Prout's paper, as directed by Dr. Thomson, who unfortunately has forgotten to quote the *corrections*.

Mr. Elmes on the Construction of Prisons.

To the Editor *of the* Journal *of* Science *and the* Arts.

Sir, *February* 2, 1818.

In your last Number, Mr. J. C. Loudon has done me the honour of speaking of my late publication, "Hints *for the improvement of* Prisons," in terms of commendation, for which I here take leave to thank him :—but in his very outset he insinuates that his communication to you, is "in addition to the information" given to the public by me. This is so contrary to the facts, that I cannot suffer it to pass by unnoticed, as that part of the public who reads your very useful work, may perhaps never see mine, and unfair opinions of it and me, may be the results.

Mr. Loudon next says, that his general plan, has the following "advantage, which is indeed *its characteristic, that a prisoner may, during the whole time of his imprisonment, keep himself perfectly retired and unseen by any other prisoner, if he choose*;" and of course this being "in addition to" mine, it is no part of my plans. In reply to this, I have only to request attention to page 16 of my work, where the third advantage of my system is fully stated to be that "from each prisoner having perfect seclusion from the rest, in the night, or whenever such seclusion may be desirable." So much for Mr. Loudon's "characteristic" being "in addition to" mine.

Mr. Loudon then, most properly, exposes the defects of almost all the prisons and penitentiaries, both in England and

on the continent, which he says are the want of the means of a complete and constant separation of prisoners; and then says, that the design which he submits to you possesses the advantages of *security* and *space for air and exercise*, with the means of *complete* and continual *separation*, "more completely than any prison yet built in this country, and in execution is not more than usually expensive." This assertion also by implication insinuates from the first quotation that this is also in addition to mine. In reply, I shall again refer to my pamphlet, page 15. I expressly state my first object to be, "that most desirable of all, *a complete classification and subdivision of all the prisoners*;" and to those who have not my pamphlet, I beg to refer to the Monthly Magazine for October last, where one of my plans has been selected, and this very object explained and commended, although the whole of my plans have not had the good fortune to meet the approbation of my critic.

With regard to Mr. Loudon's plan, it would not be becoming in me to say much; but thus far I feel at liberty to assert, that his plan has been published subsequently to mine, which he acknowledges to have seen; that all the practical advantages stated to be in his, are in mine; that I desire nothing more than that your candid readers will peruse and compare both our plans, and award the palm of originality to him who deserves it. However, Mr. Howard and others, to whom I have publicly acknowledged my obligations, will take a considerable share.

I also think myself at liberty to say, that with all the ingenuity of Mr. Loudon's plan, it is evidently too much the work of a theorist; that his little yards would be in execution unwholesome sinks, his communicating galleries cumbrous and unuseful, and his radiated passages, splendid delusions.

I have endeavoured in mine, to throw aside all I had learnt in the office as a draftsman and designer; all my plans have been designed for economical execution; and I do not hesitate in asserting, they are the cheapest and most secure of any yet executed.

In saying this, I deprecate the charge of egotism, and boasting; the system is neither mine nor Mr. Loudon's, but

Howard's; therefore I am bold in praising what that great man suggested. I have, as I confess in my preface, done little more than make *practical* illustrations of that great philanthropist's inexecutable theories.

That you may judge for yourself, I have taken the liberty of enclosing you one of my pamphlets, and trust to your candour and liberality, to do me justice by reading the parts I have marked, and inserting this letter, with any remarks or quotations you may think proper to honour me by inserting, in your valuable and highly useful work.

I am, Sir, &c.

James Elmes.

We beg to thank Dr. Francis of New York, for his correspondence and promised communications; and are obliged to Messrs. Eastburn and Co. for the copies of the American reprint of our Journal, and much flattered by their high opinion of its merits.

The difficulty of communicating with Mr. Watts, and the extreme accuracy required in printing a paper of the description of that with which he has favoured us, has obliged us to omit it in the present Number. We shall be happy to act up to his suggestions respecting it, on any future occasion.

Our Correspondent F. C. M. need be under no apprehension of our falling into the error which he kindly cautions us against. The article he alludes to has no "party spirit" in it; any other person who had similarly written would have been similarly spoken of, as indeed one of the articles referred to amply shews. The other notion is really too silly to require a grave answer. This Journal is *edited* at the Royal Institution, by permission of the Managers, and consistently with the "Bye Laws," but the *Editors* alone direct its contents, and are *solely* responsible for them. In other respects, we are much obliged by F. C. M.'s very sensible advice, which, however, he must be fully aware is easier given than followed?

Semper ego auditor tantum? Nunquamne reponam?
Vexatus toties? * * * *

Art. XXIV. Meteorological Diary for the Months of December, January, and February, 1818, kept at **Earl Spencer's** Seat at Althorp, in Northamptonshire. The Thermometer hangs in a north-eastern aspect, about five feet from the ground, and a foot from the wall.

METEOROLOGICAL DIARY
for December, 1817.

		Thermometer.		Barometer.		Wind.	
		Low.	High.	Morn.	Even.	Morn.	Even.
Monday	1	50	53	29,68	29,60	SW	SW
Tuesday	2	45	45	29,48	29,38	W	W
Wednesday	3	28,5	41	29,42	29,60	WbN	NE
Thursday	4	29,5	42	29,81	29,82	NW	SW
Friday	5	35	47	29,48	29,42	WbS	S
Saturday	6	36	40	29,30	29.30	W	NW
Sunday	7	30	41	29,30	29,21	WbS	W
Monday	8	33	40,5	28,56	28,51	SW	N
Tuesday	9	35	39	29,07	29,10	WbN	NW
Wednesday	10	29	34	29,18	29,28	WbN	WNW
Thursday	11	24	31	29,40	29,45	WNW	W
Friday	12	18	32	29,52	29,55	W	SE
Saturday	13	33	39	29 47	29,50	SE	ESE
Sunday	14	37	45	29.40	29,32	E	SE
Monday	15	31	42	29.49	29,50	WSW	SW
Tuesday	16	33,5	49	29.70	29,49	S	SE
Wednesday	17	37	41	29,49	29,50	W	WSW
Thursday	18	40,5	44	28,80	29,78	W	WbS
Friday	19	36	43	28,56	28,80	WbS	WbN
Saturday	20	38	39	29,40	29,54	NE	NE
Sunday	21	27	33	29.47	29,47	ENE	ENE
Monday	22	29	34	29.47	29.47	E	EbS
Tuesday	23	25,5	30	29.48	29,46	NbN	NW
Wednesday	24	18,5	32	29,63	29,75	NE	N
Thursday	25	27	32	29,89	29.98	N	N
Friday	26	22	31	30,01	29,99	W	SW
Saturday	27	27	37	29,70	29,40	WbS	WSW
Sunday	28	31	36	29,60	29,84	WbS	NW
Monday	29	25,5	32,5	30,05	29.02	W	WSW
Tuesday	30	31	38	29,88	29,88	WbS	WSW
Wednesday	31	22	31	29,97	29,97	WbS	W

METEOROLOGICAL DIARY

for January, 1818.

		Thermometer.		Barometer.		Wind.	
		Low.	High.	Morn.	Even.	Morn.	Even.
Thursday	1	19,5	27,5	29,97	29,97	W	ENE
Friday	2	28	34	30,00	29,94	E	E
Saturday	3	28	33	29,56	29,49	E	ESE
Sunday	4	34	41	29,38	29,49	SE	SSW
Monday	5	32	40,5	29,39	29,38	S	E
Tuesday	6	33	41	29,88	30,05	WNW	W
Wednesday	7	31	44	29,98	29,78	WSW	W
Thursday	8	34	40	29,99	30,12	W	W
Friday	9	32	45,5	29,92	29,82	W	WSW
Saturday	10	40,5	50	29,68	29,68	SW	WSW
Sunday	11	43,5	47	29,68	29,51	WSW	SSW
Monday	12	36	46	29,77	29,92	W	SW
Tuesday	13	37	51	29,65	29,68	SW	W
Wednesday	14	37	50	29,68	29,72	NE	WbS
Thursday	15	38	53	29,49	29,47	SW	W
Friday	16	42	48	29,70	29,50	SW	SW
Saturday	17	36	42	29,60	29,78	W	W
Sunday	18	33	40	29,78	29,93	W	W
Monday	19	29	38	30,28	30,30	W	SW
Tuesday	20	32,5	41	30,29	30,08	SW	SW
Wednesday	21	33	42	29,70	29,97	S.	W
Thursday	22	31	44,5	29,82	29,47	SW	SW
Friday	23	31	38	29,50	29,40	W	W
Saturday	24	32	41	29,38	29,42	SW	W
Sunday	25	30	41	29,84	29,82	W	SSW
Monday	26	42	48	29,70	29,50	WbS	W
Tuesday	27	31	41	29,73	29,60	W	S
Wednesday	28	35,5	41,5	29,40	29,40	WSW	W
Thursday	29	28,5	39	29,50	29,33	W	SE
Friday	30	37	43	28,83	28,82	WSW	W
Saturday	31	32,5	36	29,10	29,30	W	W

METEOROLOGICAL DIARY

for February, 1818.

		Thermometer.		Barometer.		Wind.	
		Low.	High.	Morn.	Even.	Morn.	Even.
Sunday	1	31	38	29,00	29,00	W	W
Monday	2	26	33,5	28,89	28,89	SW	WbN
Tuesday	3	21	34	29,00	29,07	SE	NW
Wednesday	4	20	30	29,07	29,07	E	NE
Thursday	5	24	39	29,32	29,50	SSW	SSW
Friday	6	25	37	29,86	29,80	W	SSW
Saturday	7	23	35	29,88	29,90	WbS	WbS
Sunday	8	25	37	29,86	29,86	W	W
Monday	9	29,5	37,5	29,86	29,86	W	WbS
Tuesday	10	22	35	29,86	29,89	SSE	EbS
Wednesday	11	26	30	30,00	30,05	SE	S
Thursday	12	29	33	30,05	30,00	SW	SE
Friday	13	31	35	29,94	29,85	E	SE
Saturday	14	22	35,5	29,73	29,63	E	EbS
Sunday	15	31	37	29,75	29,75	SE	ESE'
Monday	16	32	45	29,75	29,75	ESE	SE
Tuesday	17	37	49	29,79	29,77	E	S
Wednesday	18	41	47	29,71	29,67	S	SSW
Thursday	19	30	46	29,80	29,68	S	S
Friday	20	31	43	29,87	29,85	S	S
Saturday	21	33	44	29,55	29,20	S	S
Sunday	22	29	38	29,18	29,00	SbW	ENE
Monday	23	28	41	29,56	29,50	W	SbW
Tuesday	24	32	43	29,53	29,63	W	SW
Wednesday	25	40	51	29,39	29,34	W	W
Thursday	26	30	41	29,35	29,59	W	W
Friday	27	32	47	29,38	29,20	SW	WbS
Saturday	28	33	47	29,49	29,27	W	SW

Select List of New Publications during the Three last Months.

BOTANY.

Muscologia Britannica, containing the Mosses of Great Britain and Ireland, systematically arranged and described; with plates illustrative of the characters of the genera and species. By W. Jackson Hooker, F. R. S. and Thomas Taylor M.D. M.R.I.A. &c. With 31 plates, 8vo. 1*l.* 11*s.* 6*d.*

MATHEMATICS AND NATURAL HISTORY.

Nautical Almanack and Astronomical Ephemeris. Published by order of the Commissioners of Longitude, for the years 1818, 19, and 20. Royal 8vo, 6*s.* each.

Tables requisite to be used with the Nautical Almanack for finding the Latitude and Longitude at Sea, 8vo. 5*s.* The Appendix, 2*s.*

Evening Amusements, or the Beauties of the Heavens displayed; in which several striking appearances to be observed in various evenings in the Heavens, during the year 1818 are described. By W. French, Esq. M. A. 12mo. 3*s.*

A Synoptical Catalogue of British Birds, intended to identify the species mentioned by different names in several catalogues already extant. By Thomas Forster, F. L. S. 8vo. 3*s.*

MEDICINE, ANATOMY, AND CHIRURGERY.

Account of some Experiments made with the Vapour of Boiling Tar, in the cure of Pulmonary Consumptions. By Alex. Crichton, M. D. F. R. S. 8vo. 2*s.* 6*d.*

Transactions of the Association of Fellows and Licentiates of the King's and Queen's College of Physicians in Ireland, 8vo. vol. 1*l.* 14*s.*

Medico-Chirurgical Transactions, published by the Medical and Chirurgical Society of London. 8vo. vol. 8. part 2. 10*s.* 6*d.*

An Essay on the Disorders of Old Age, and on the means for prolonging human Life. By Anthony Carlisle, F. R. S. F. S. A. F. L. S. 8vo. 5*s.*

The Continental Medical Repository. By E. Von Embden. Nos. 1 and 2. 8vo. 3*s.* 6*d.* each.

Observations on some important points in the practice of Military Surgery, and in the arrangement and police of Hospitals, illustrated by Cases and Dissection. By John Hennen, Deputy Inspector of Hospitals. 8vo. 12*s.*

Memoirs and Reports on the efficacy of Sulphurous Fumigation in the treatment of disease of the Skin, Joints, and Glandular System, &c. &c. &c. From the French of J. C. Gales, M. D. Illustrated with several coloured Engravings, 118 Cases, and copious Observations. By Rees Price, Member of the Royal College of Surgeons, 8vo.

An Essay on the Human Ear, descriptive of the causes of Deafness, Diseases of the Ear, modes of Cure. &c. By W. Wright, Esq. Surgeon Aurist to her Majesty. 8vo. 6*s*.

Navigation.

The possibility of approaching the North Pole asserted. By the Hon. Daines Barrington. With a Map and additional Observations. By Col. Beaufoy, F. R.S. 8vo. 9*s*.

Topography, Voyages, and Travels.

The History and Antiquities of Croydon. By the Rev. D. W. Garrow, B. D. with plates, 8vo.

Anecdotes respecting Cranbourne Chase. By W. Chafin, Clerk. 8vo. 4*s*.

Introduction to the Beauties of England and Wales, comprising Observations on the History and Antiquities of the Britons, the Romans in Briton, the Anglo-Danes, Anglo-Saxons, and Anglo-Normans. Together with Remarks on the progress of Ecclesiastical, Military, and Domestic Architecture in succeeding Ages. With Maps, &c. &c. By James Norris Brewer. Demy 8vo. 1*l*. 4*s*. royal 8vo. 1*l*. 11*s*. 6*d*.

Observations, Moral, Literary, and Antiquarian, made during a Tour through the whole of the Pyrennees, France, Switzerland, Italy, and the Netherlands, in the years 1814 and 1815. By John Milford, Jun. late of St. John's College, Cambridge. 8vo. 2 vols. 1*l*. 1*s*.

The Narrative of Captain Tuckey; the Journal of Professor Smith; and Miscellaneous Observations on a Voyage of Discovery up the River Zaire, or Congo, in South Africa; with an Introduction explanatory of the Motives and Objects of the Expedition, with Biographical Notices of the unfortunate Sufferers: and an Appendix, containing a systematic Account of the Natural History of Congo, along the Line of the River. With a Chart of the River, several Engraved Views, numerous Wood Cuts, and Plates of new and interesting Objects of Natural History. Published under the direction John Burrow, Esq. F. R. S. In 1 vol. 4to. 2*l*. 2*s*.

Account of a Voyage of Discovery to the Western Coast of Corea, and the Great Loo Choo Island, in the Japan Sea, in H. M. S. Lyra. By Captain Basil Hall, R. N. F. R. S. L. et E. with a Vocabulary of the Language of that Island by Lieutenant Clifford, R. N., and an Appendix, containing Charts and various Hydrographical and Scientific Notices. Illustrated by Eight coloured Engravings, after Drawings by Havell, of Scenery, and the Costume of the People of Corea, and particularly of the more interesting Inhabitants of Loo Choo. In one volume, 4to. 2*l.* 2*s.*

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II.

A COMPENDIUM of UNIVERSAL GEOGRAPHY, or a Description of every Part of the World, upon a new Plan, according to the Grand Natural Divisions of the Globe; preceded by a History of Geography, Ancient and Modern; and with a General Theory of Mathematical, Physical, and Political Geography. Translated from the last edition of M. Malte-Brun; with very important Additions, in 6 vols. 8vo.

THE QUARTERLY JOURNAL

OF

SCIENCE AND THE ARTS.

Art. I. *Signor* Monticelli's *Report to the Royal Academy of Sciences at Naples, upon the Eruption of Vesuvius in December* 1817.

This eruption of Mount Vesuvius began on the 22nd, and terminated on the 26th of December last. On the 23rd I was at Resina, and on the 24th at Torre del' Annunciata, so that I had an opportunity of observing the two currents of lava, one of which ran towards the plain of Pedimentina, the other towards Mauro. On the 24th, I remarked that the small conical hillock which stood near the centre of the edge of the crater had disappeared; it seemed swallowed up by the same ignivomous aperture which raised it in 1816. The other smaller hillock upon the western ridge of the crater had also fallen in, and was swallowed up by a very large rent upon that side of the Volcano.—Instead of these hillocks, I found the recent lava curiously disposed in the manner of a wall, fortifying, as it were, the antient crater upon the east and west sides; convex, and very irregular upon the north and south. Of this wall some parts are quite even and regular, looking exactly like our terraces; the whole was extremely hot, and apparently incandescent in the interior, as seen through some of the holes and fissures. I have little doubt that parts of these walls were hollow, not only from this appearance, but from the sound occasioned by throwing a large stone upon any

part of them. Upon the south, all former appearances are destroyed, and there has been produced a very gently inclined plain, covered with fine sand; indeed it would have been impossible here to have recognized the former edge of the crater, were it not for two large blocks of stone which were thrown up in the eruption of 1812, and which, though much changed by the action of two small *fumarolee* underneath them, which have burned since the year 1815, still serve as landmarks. This plain is often traversed by long fissures more or less perpendicular, running east and west.

On the second of March we counted round the crater fourteen apertures, most of which were still smoking; one of them was circular, and about two feet in diameter; it was perfectly quiet, and appeared of an unfathomable depth. The largest of them is on the northern side of the crater, at a little distance from the great fissure which rent the cone asunder during the eruption of 1813, and which has been intirely obliterated, or at least covered by the late formation of lava. Upon the north-east side, a little above the sandy plain, is the new crater, which poured forth the lava that cut the cone of the volcano, and took the direction of Mauro. This lava spread round the antient Somma, and upon the east side of that mountain descended through a wood, and passing before a house belonging to the Prince of Ottaiano, reached to within a very short distance of the principal street of Mauro. On the 26th of December, while we were observing the progress of the torrent, from a small wood of oaks near the Prince's Casino, we were suddenly surprised and alarmed by the motion of the ground we were standing upon, and immediately afterwards, three small jets of flame made their appearance at a few feet only from us; we therefore hurried away to a place of safety, expecting a repetition of the same phœnomenon, but we only observed jets of smoke here and there in the wood.

Whilst observing Vesuvius on the 24th of December, I remarked lava flowing from five apertures, which augmented the current that formerly issued from the south side of the cone previous to the destruction of Torre del Greco, and in which

were small apertures emitting flame, and rapidly appearing and disappearing in succession. The light was very intense and splendid.

On the north of the great fissure of the crater above alluded to, the recent lava assumed the aspect of basaltic columns.

On the 27th of December, a cavern near Mauro was covered with a white incrustation of salt, sublimed from below; its quantity was so considerable, that 50 or 60 people made a profitable occupation of collecting it; for this purpose they either broke the stones, or scraped off the saline matter, and replaced them in their former situations, and a day or two afterwards they became again covered as before. We often saw the deposition of this sublimate, which I am induced to believe required the presence of air for its formation, for it only existed near the surface, or in cavities open to the access of atmospheric air. The same observation applies to the beautiful specimens of sublimed oxide of iron *(fer oligiste)*. Various other sublimates were deposited upon the lava, but in much smaller quantity; their colours were chiefly yellow, red, and green; they were most abundant near the large crater; the yellow and red were deliquescent; but the yellow and green permanent. The smell of muriatic acid, though frequently perceived near the large burning orifice of the mountain, was never observed in the lava of Mauro.

The sand ejected during this eruption was of two kinds; one red and in large grains, found upon the west ridge of the mountain; the other of a colour approaching to violet, and much finer.

On the 25th the air was dark; there was not a breath of wind; but the sea on the coast was extremely agitated. In the evening there was a hail storm accompanied by red sand.

Art. II. *Instructions for the Adjustments and Use of the Instruments intended for the Northern Expeditions.**

Captain Kater's Directions for the use of the Instruments executed under his Superintendance.

One of the many objects of scientific research which present themselves on the present occasion, is the length of the pendulum vibrating seconds in a high northern latitude; and from the excellence of the instruments provided, we may confidently hope for results on this and on various other subjects, far more satisfactory than any that have yet been obtained.

A *Clock* is sent out with each Expedition, the pendulum of which, cast in one solid mass, vibrates on a blunt knife edge resting in longitudinal sections, of hollow cylinders of agate. The points to be determined are, the number of vibrations made by the pendulum of this clock in a certain known interval of time; the arc in which the vibrations are performed; the temperature; the height of the barometer; the latitude and longitude of the place of observation; and (if practicable) its elevation above the level of the sea.

A *Transit* accompanies each clock, the adjustments of which are,

To place the vertical wire perpendicular to the horizon; and

The line of collimation at right angles to the axis. The level requires no correction, it having been permanently adjusted by the maker.

Slide the eye piece in or out till the wires are seen distinctly. Direct the telescope to some distant and well defined small object, and turn the milled head which is on the side of the transit till the object is seen with perfect distinctness. Place the level on the axis, and bring the bubble to the middle by

* These Instructions were printed by desire of the Council of the Royal Society, and copies were distributed among the proper persons employed on the above occasion.

the screw which elevates or depresses one of the Ys. The axis of the transit will then be parallel to the horizon.

Having brought the object to the central vertical wire by means of the screws which act horizontally on one of the Ys, observe whether the same part of the object is covered by the wire whilst the telescope is elevated or depressed, and if not, correct half the apparent deviation by turning round the cell which contains the wires.

The vertical wire covering some well defined distant object, take the instrument out of the Ys, and carefully invert it, when, if the wire no longer covers the same part of the object, correct half the error by means of the screws which act horizontally upon the wires, unscrewing the one and screwing the other; and the remaining half by the screws which act horizontally on one of the Ys. Repeat this operation till the vertical wire covers the same part of the object in both positions of the telescope; the line of collimation will then be perpendicular to the axis.

These adjustments once made will seldom vary.

Of the Observations necessary to obtain the Number of Vibrations made by the Pendulum of the Clock during a certain interval.

Screw the triangular support of the clock very firmly together, and having taken off the head, fix the clock-case to the support by the screws for that purpose. Bring the bubble of the level which is near the agates, to the middle by means of the screw which acts on the piece projecting behind from the triangular support, taking particular care that the three legs of the support rest on a very firm foundation, as on the stability of this will depend in a great measure the accuracy of the results. Next, see that the fork which is connected by a joint to the crutch is perpendicular, as it would otherwise be liable to injury.

The pendulum is now to be taken from its case, and carefully passed up through the aperture which is made to admit it at the back of the clock, and gently lodged on the brass near the agate. In this part of the operation the most minute

caution is necessary to keep the pendulum as nearly perpendicular as possible, in order that the weight of the ball may not bend the rod.

The pendulum may now be held by the rod with one hand and raised, whilst the other hand is employed in guiding the knife edge, so that it may be properly lodged in the agate cylinders. The figure engraved on the ball of the pendulum should be in front.

Turn up the fork attached to the crutch, so that it may embrace the rod of the pendulum. Hang on the weight, wind up the clock, replace the head of the case, and then gently set the pendulum in motion. Listen to the beats of the pendulum, and if they are not made at equal intervals, unscrew the lower screw which attaches the clock case to the triangular support, and move the clock case a very little to the right or left, till the beats are perfectly equalized. When this is effected, let the screws which attach the clock case to the support be firmly tightened.

The thermometer is now to be hung in its place in the clock case; and the door being open, the whole is to be left for some hours, that the pendulum may acquire the temperature of the surrounding atmosphere.

During this interval, the transit instrument may be put up, and screwed to the firm block provided for its support.

When the pendulum may be supposed to have attained a steady temperature, the next step is to compare the clock with a chronometer which I shall call No. 1, distinguishing the others by Numbers 2, 3, &c. Shut the door of the clock case, and set down the hour shewn by the clock, and the minute which is about to be completed. Place the ear close to the clock, and begin counting the seconds, looking at the same time at the chronometer No. 1, and on counting 60 seconds, which will complete the minute of the clock registered, mark carefully the second, and fraction of a second shewn by the chronometer, and set this down together with the minute and hour. Open the door of the clock case, and observe the height of the thermometer, taking it by estimation to the tenth of a degree. Next, remark the extent of the arc of vibration of

the pendulum, for which purpose a black line is drawn at the bottom of the ball. The mean of the arcs observed to the right and left, will be the true arc of vibration to be registered, and this must be estimated to the tenth of each division of the arc. This completes the comparison of the clock with the chronometer No. 1, and the clock case is now to be shut.

Compare the chronometer No. 1, with No. 2, No. 3, &c., and according as these last are *faster* or *slower*, *add* or *subtract* their respective differences to the time shewn by chronometer No. 1, before registered. The results will be the times which were shewn by the chronometer No. 2, &c. when the clock was compared with No. 1, which times are to be registered in appropriate columns, the rate of each chronometer being noted at the head of its column. The height of the barometer may also be now registered.

The temperature and arc of vibration should be observed and set down at equal intervals of two or three hours, in order to obtain a true mean of both.

At the end of ten or twelve hours, the comparison of the chronometer No. 1. with the clock and with the other chronometers is to be repeated, and the observations will be continued in like manner during as long a period as circumstances may permit.

The following form may be found convenient for registering the observations.

At - - Lat.		Long.	Height above the sea				
Date.	Time by the Clock.	Time by Chron. No. 1. gaining (or losing.)	Time by Chron. No. 2. gaining (or losing.)	Time by Chron. No. 3. gaining (or losing.)	Temperature.	Arc of Vibration.	Barometer

During the course of the observations above described, others will be made with the transit, when the weather permits in the following manner.

The error of the chronometer must be determined, and the transit brought nearly into the meridian, in the manner which will be detailed in treating of the variation transit. For it must be recollected that it is not necessary to bring the transit *accurately* into the meridian, as the interval of time shewn by the clock between the successive transits, and the date of the observations, are all that is required.

A meridian mark, which accompanies the clock, is now to be sent to as great a distance as may be convenient in front of the transit, and the person who carries it will move to the right or left by signal till it is in the field of the telescope, when it is to be firmly fixed in the ground, and the part of it intersected by the vertical wire, particularly noted, so that the observer may be certain of bringing the transit again accurately to the same point, should it suffer any change of position; and this adjustment must be carefully attended to, previous to every observation.

The following noon, the transit being levelled, and brought, if necessary, to the meridian mark, the time shewn by the clock when the sun's centre passes the meridian, is to be determined by observiug the transit of each limb over the five wires, and the temperature by the thermometer in the clock case; the arc of vibration and height of the barometer must also be noted in the manner already detailed; the following is the most convenient form for registering the observations.

First Limb.		Second Limb.		Mean.
Wire.	Time.	Time.	Wire.	
1			5	
2			4	
3			3	
4			2	
5			1	
Transit of ☉'s centre.				

The transit of the sun will thus be taken whenever the weather will permit, *carefully remembering to refer constantly to the meridian mark*, and to level the axis of the instrument. Thus will be obtained by two separate methods, one of which is independent of unfavourable weather, data from which to deduce the comparative length of the pendulum at London, and at the place of observation, together with the conclusions dependant on this interesting subject of enquiry.

Of the Adjustments on the Variation Transit.

1. Place the vernier of the horizontal circle at the 90th degree. Open the covers of the Ys and take off the microscope cap. Place the telescope horizontal, the level hanging below the axis, and by means of the screws which support the instrument, bring the bubble to the middle of the level.

Take the telescope out of the Ys, and turning it half round horizontally, replace it carefully in them, when if the bubble is not in the middle, cause it to return through half the quantity of the variation by means of the serews belonging to one of the arms attached to the axis of the instrument, and

give the time shewn by the chronometer when the sun's first and second limbs are on the meridian.

Place the magnetic transit on its support, so that the needle may be at liberty to take the direction of the magnetic meridian, and the vernier being at 180°, and the telescope horizontal, with the level beneath the axis, bring the bubble to the middle of the level. Do the same, the vernier being at 90°, and repeat the operation if necessary, till the bubble remains stationary in the middle in both positions.

A little before the time of the sun's first limb coming to the meridian, direct the telescope to the sun, and clamp the tangent screw firmly to the azimuth circle. Let an assistant count the seconds of the chronometer aloud, whilst the observer by means of the tangent screw carefully keeps the first limb of the sun on the central vertical wire, and when the assistant pronounces the second, at which the sun's first limb comes to the meridian, the observer must quit the tangent screw, and wait till the second limb approaches the central wire; the assistant then counts aloud as before; and at the calculated second, should not the last limb of the sun be accurately on the wire, the observer must perfect the contact by means of the tangent screw.

The variation transit being now, it is to be presumed, very nearly in the meridian, the degrees and minutes shewn by the vernier are to be registered; and it would be advisable to bring the telescope down to the horizon and remark whether either of the wires bisects some well defined object, by means of which the instrument may again be brought into the meridian, if necessary.

Unclamp the tangent screw, and turn the instrument in azimuth till the telescope is brought parallel to to the needle. Put on the microscope cap, and directing the telescope to one end of the needle, adjust the cap till the mark on the needle is well defined; then clamp the tangent screw.

Open the covers of the Ys, and by means of the tangent screw, bring the mark on the needle to the central wire of the telescope, and register the degrees and minutes shewn by the

vernier. Do the same with the other end of the needle. Take the telescope out of the Ys, and having inverted it, repeat the observations at both extremities of the needle, being careful not to touch the microscope cap. The mean of the four readings thus obtained, will be the reading at the magnetic meridian, the difference between which and the reading, when the telescope was in the true meridian, will give the variation of the needle, which is either east or west, as the north point of the needle is east or west of the true meridian.

Great care must be taken that no iron is in the tent, or about the person of the observer, during the observations.

If the sun's upper or lower limb be brought in contact with the horizontal wire during the transit, the meridian altitude may be read off on the vertical circle, and the latitude of the place of observation to a certain degree of exactness may be thus obtained.

Of the Dipping Needle.

The dipping needle, which I am about to describe, is intended also to determine the comparative intensity of the magnetic force, and this will be treated of in the following article. The needle is supported on horizontal planes of agate by an axis which passes through it, and the proper situation of the axis is determined by means of two Ys, in which it is to be lodged; and these are gently lowered till the axis rests wholly on the agate planes. The needle vibrates within a circle divided in the usual manner.

The agate planes may be placed horizontal by a level fixed to the piece in which they are embedded, and there is also a small level at right angles, to adjust the plate which supports the vertical circle.

A horizontal needle accompanies the instrument, by which it may be placed in the magnetic meridian. All the other adjustments are so contrived as to be permanent; nothing therefore is necessary but to describe the manner of using the instrument.

Take off the glass cover, place the horizontal needle on its

support, and turn the instrument in azimuth, till the point of the needle corresponds with the mark on the horizontal plate. Level the instrument by means of the three screws which support it, and again examine the needle, and correct any deviation from the mark on the horizontal plate. Remove the horizontal needle, and having elevated the Ys, place the axis of the dipping needle in them, and put on the glass cover. Lower the Ys very gently, till the axis of the needle is left on the agate planes, when the needle will be at liberty to direct itself towards the magnetic pole. Elevate and depress the Ys thus repeatedly, and read off the degrees and minutes indicated by the marks at each extremity of the needle. Next, turn the instrument in azimuth 180°, and having corrected the level if necessary, repeat the observations which have just been detailed in this position of the circle. To the mean of the readings thus obtained, apply the correction written on the board which supports the instrument, and the result will be the true dip.

Of the Magnetic Force.

In using the needle for ascertaining the intensity of the magnetic force, nothing more is necessary than to determine the number of vibrations made by the needle in a certain portion of time, together with the arc in which these vibrations are performed. For this purpose the instrument being adjusted, as directed in the preceding article, and the Ys lowered so that the axis rests on the agate planes, let the needle be drawn from its position by applying the horizontal needle above or below one end of it; the dipping needle will now begin to vibrate, and an assistant must mark the time when it arrives at the extremity of its arc, and the degree shewn by the needle. The vibrations are now to be counted as long as they are of sufficient extent to be readily distinguished, and the arc observed and registered at every tenth vibration. On the completion of the last vibration, a signal will be given to the assistant to mark the time, which being registered together with the degree shewn by the needle, the observations in this position of the needle will be finished.

Raise the Ys, turn the instrument at right angles to its first position, lower the Ys, and repeat the observations in the manner just detailed. Thus will be obtained the number of vibrations in the magnetic meridian, and at right angles to it, from which, and the number of oscillations made by the same needle in London, may be derived the comparative magnetic force and the dip.

Of the Repeating Circle.

This excellent instrument, perhaps too little known and appreciated in England, is admirably adapted to occasions where the object is to combine much accuracy with great portability. In high northern latitudes, the change in the altitude of the sun is so slow, that the instruments usually employed, would not be found sufficient to enable the observer to obtain his time from noon with the necessary degree of precision. A repeating circle has therefore been added to the instruments accompanying each Expedition, to supply this defect.

The principal parts of the repeating circle are the front telescope, carrying four verniers, by which the arc may be read off to ten seconds; the vertical circle; and the level, which is attached to a telescope called the back telescope, used only in taking terrestrial angles. There is also a small level, parallel to the axis of the instrument, by means of which the plane of the circle may be placed perpendicular to the horizon. The large level, the circle, and the front telescope, may be moved together, or separate, at pleasure. A clamp underneath the axis fixes the circle, and a tangent screw above, is provided for slow motion. The level, or the front telescope, may also be clamped at pleasure to the circle, and each is furnished with a tangent screw. The instrument may be turned in azimuth, and has an azimuth circle, which reads off by means of verniers to ten seconds.

Two brass cups are provided to receive two of the screws which support the instrument: the third screw is to rest on a triangular piece of brass, ingeniously contrived to give slow motion by a fine screw at one of its angles.

Though the repeating circle has been already adjusted, it may not be superfluous to state the manner in which this may be effected.

1. To place the axis of vision parallel to the circle.

Bring the circle as nearly as possible to a vertical position, and bisect some very distant object with the perpendicular wire. Turn the instrument in azimuth precisely 180°, and the telescope again to the object, when if the wire does not bisect the same spot, correct half the error by the screws which act horizontally on the wires, and the remainder by the tangent screw of the azimuth circle: repeat this if necessary, till the object is bisected in both positions of the telescope.

2. To place the plane of the circle truly vertical, and the small level at right angles to it.

Choose some high and well defined stationary object, and bisect it with the vertical wire. Bring the telescope down, and view the same object by reflection, from a surface of mercury or water, and if the wire should not bisect the reflected image, correct half the deviation by the screws which support the instrument, and half by moving the circle in azimuth. When this adjustment is perfect, the circle will be truly vertical, and the bubble of the small level being brought to the middle by its proper screws, serves as a future means of placing the plane of the circle in a vertical position.

3. To place the horizontal wire truly parallel to the horizon, the circle being vertical.

Bisect some well defined object with the horizontal wire, and moving the instrument in azimuth, remark whether the same part of the object continues covered by the wire; and if not, correct half the deviation by turning the cell containing the wires, and the remainder by moving the telescope. When the object continues accurately bisected during the motion in azimuth, the adjustment is complete.

To find the Index Error.

Place the first vernier accurately at zero; then, read off the second, third, and fourth verniers, in the direction of the divisions of the circle, and set down these readings with their

proper signs as they are +, or — under the first. Collect all these together into one sum, and take the mean, which will be the index error, to be applied as a correction with an *opposite sign* in the manner hereafter described.

Of the Use of the Repeating Circle.

The principal use of the Repeating Circle on the present occasion, will be to determine the error of the chronometer, either by the zenith distance of the sun, or by equal altitudes.

For the first, to determine the zenith distance of the sun, and the corresponding time, shewn by the chronometer, level the instrument by means of the small level, and place the first vernier at zero by the clamp and tangent screw, and the front telescope being to the left hand, bring it to the sun, and clamp the circle. Turn round the large level till the bubble is near the middle, and having clamped it to the circle, adjust the bubble more accurately by its tangent screw. I have supposed the circle so placed, that the limb of the sun intended to be observed is approaching the horizontal wire. Adjust now, if necessary, the bubble of the small level, that the circle may be truly vertical, and now wait till the sun's limb touches the horizontal wire. The time at which the contact takes place, must be noted by an assistant, and registered.

The ivory scale of the level, is divided into parts, each of which shews one second of inclination, and there are two marks indicating its zero. Observe now the distance of each end of the bubble from its zero, and write down these two distances in a line with the time, prefixing the sign + or — according as either end of the bubble, is *nearer to*, or *further from* the observer than the mark indicating zero.

Turn the instrument in azimuth half round; adjust, if necessary, the small level, and by means of the tangent screw which moves the circle, bring the bubble of the large level near to the middle. Unclamp the front telescope, and bringing it to the sun, clamp it again, and by its tangent screw, adjust it so that the limb of the sun before observed, may be a little short of the wire. Wait till the limb comes in contact with

the wire, note the time, and register it together with the readings of the ends of the bubble of the level, as before. This completes one set of observations, and if the verniers were now read off, the correction for the level and index error applied, and the result divided by two, the apparent zenith distance due to the mean of the observed times would be obtained. But we will suppose that greater precision is required. Instead, therefore of reading off, turn the circle in azimuth to its original position (remembering always to lay hold of the pillar for this purpose), unclamp the circle, and by turning it, bring the telescope again to the sun, using the back telescope as a handle; clamp the circle, and if necessary, adjust the small level; unclamp the large level, and bring it back till its bubble is near the centre; clamp it again to the circle, and bring the bubble nearer to its zero by the tangent screw. Observe the contact of the limb and the horizontal wire, as in the first observation, registering the time, and the readings of the ends of the bubble. Turn the instrument again half round in azimuth, and proceed as in observing the second contact. Now read off and register the degrees, minutes, and seconds, shewn by the first vernier, under which write the minutes and seconds shewn by each of the other verniers, of which take the mean, and to this apply the correction for the index.

Add up each column of the readings of the level, carefully prefixing the proper sign, and take the mean of the results. Apply it according to its sign, to the result before obtained. Divide this, by the number of observations (in the present instance four), which will give the apparent zenith distance of the observed limb, answering to the mean of the times shewn by the chronometer, from which, the true altitude, and error of the chronometer, may be obtained in the usual manner.

It must be carefully recollected that when the circle is to the *left* hand, the *front telescope* is on no account to be touched, and when to the right hand, the *level* is to remain immoveably attached to the circle.

It may not be superfluous to subjoin an example of the mode of registering the observations.

Time by the Chronometer.	Readings of the level.		Readings on the circle.	
° ′ ″	″	″	⊙'s upper Limb.	
3 27 43,5	+ 3	− 11		
30 39,5	+ 50	+ 48		
32 15,5	+ 8	− 8		° ′ ″
34 5,5	+ 2	− 14		
				234 0 40
3 31 11,0	+ 63	+ 15	Second ver.	45
	+ 15		Third ver.	45
			Fourth ver.	30
2	+ 78			
				234 0 40
Correction	+39		Level	+ 39
			Index	+ 1,2
		4		234 1 20,2
Apparent zenith distance				58 30 20

To observe equal Altitudes with the Repeating Circle.

Clamp the front telescope firmly to the circle, and bring the vernier to zero. Level the instrument, and direct the telescope to the sun by turning the circle. Fix the circle, and having turned the level till the bubble is near the centre, clamp it very firmly, and by means of the tangent screw, bring the bubble accurately to the middle of the level. Examine also the small level. The telescope should have been directed so much above the sun, that the upper limb may not have arrived at either of the three horizontal wires of the instrument. The circle being thus adjusted, observe the time when the sun's upper limb comes in contact with each of the three horizontal wires. Do the same with the lower limb, and if there should be occasion to move the circle in azimuth, carefully examine the levels, and re-adjust them if necessary, by the screws which support the instrument, or the tangent screw which moves the circle. The wires should be distinguished by numbering them, calling that No. 1, which the sun first

touches in the observations before noon, consequently, the wire which the sun first touches in the afternoon, will be No. 3, and the last, with which it comes in contact, will be No. 1. In the afternoon, turn the telescope in azimuth towards the sun, when he approaches the same altitude, and having carefully adjusted the levels, by the screws which support the instrument, and the tangent screw which moves the circle, observe again the times when the limbs of the sun come successively in contact with the three wires, remembering that as the sun is descending, it is now the *lower* limb which comes first in contact with the *third* wire, and which is first to be registered. Thus will be obtained six observations of equal altitudes, on each side of noon, which must be arranged in pairs, and the intervals and error of the chronometer determined by the methods which are well known.

The following form may be found convenient, adding the date, and the latitude and longitude of the place of observation.

	Upper Limb.			Upper Limb.		Intervals.
Before Noon.	1		After Noon.	1		
	2			2		
	3			3		
	Lower Limb.			Lower Limb.		
	1			1		
	2			2		
	3			3		

Of the Use of the Repeating Circle in taking Terrestrial Angles.

Though the repeating circle will not be employed for this purpose on the present expedition, yet it may be serviceable to describe the manner in which it may be used on any future occasion.

Place the vernier at zero, unclamp the *semi-circle*, and bring the circle into the same plane with the two objects, the angle between which it is required to determine. Turn the circle till the object which is to the left hand, is in the intersection of the wires which meet in the centre of the front telescope, and then clamp the circle. Bring the back telescope to the right hand object, and perfect the intersection in both telescopes by the tangent screw belonging to the circle, and that of the back telescope. Unclamp the circle, and turn it till the back telescope is brought to the left hand object. Clamp the circle, and adjust the back telescope accurately to the object by means of the tangent screw which moves the circle. Unclamp the front telescope, and bring it to the right hand object, when, if the degrees, &c. were read off, they would indicate double the required angle. If greater precision is desired, unclamp the circle, and turning it, bring the front telescope to the left hand object, and the back telescope to the right hand object, and proceed as before; repeating the process as often as may be thought necessary. The zenith distance of each object must also be taken, in order to reduce the observed angle to the horizon.

The instruments which have hitherto been described, can only be used on land.

The Use of Captain Kater's Azimuth Compass.

Of all instruments known, the common azimuth compass is perhaps the most defective. To evince this, it will be sufficient to refer to Captain Phipps' voyage, from which it appears, that though the observations were made with all possible care, differences occurred at the same time and place in the variation amounting to two, three, and four degrees, and in one instance, even to five degrees ten minutes. The instrument about to

be described, will, it is hoped, from some recent improvements made in it, afford far more accurate results.

The compass, which is five inches diameter, is held in the hand, and by means of an inclined mirror and lenses, the degrees are seen by reflection considerably magnified; a line drawn on a piece of ivory is viewed at the same time, and serves as an index by which the degrees are to be read off.

At the opposite side of the box is a sight on which slides in a frame the segment of a glass cylinder, ground to a radius of five inches. By means of this, a fine line of light is thrown on the index, and may be seen at the same time as the degrees on the card.

To use the instrument, elevate the sight, and turning it towards the sun, slide the glass along it till the line of light is thrown on the index. Adjust the sight next the eye, by sliding it in the dovetail groove till the index line is seen distinctly. Remark, now, whether the line of light seen on the piece of ivory through the lens appears narrow and well defined; and if it does not, incline the sight furthest from the eye, towards the compass, till the requisite distinctness is attained. Be careful that the sight neither leans to the right or left, but is held perpendicular to the horizon in the direction between the sun and the observer, as the neglect of this precaution is the principal source of error to be apprehended. Let the compass be now inclined towards the observer, so as to check the vibrations of the card, by bringing it in contact with the index, and two pins fixed near it for that purpose. Do this repeatedly, till the card is steady, the compass being sufficiently inclined from the observer, just to free the card from the index. The line of light being then accurately bisected by the index line, the degree, &c. also indicated by this line, may be read off at the moment that an assistant takes the altitude of the sun. If the card should not be perfectly steady, the mean of its vibrations may be very readily estimated. The degrees on the card are read from the north towards the east, and are carried round to 360°, in order to obviate the possibility of error in this respect. To the degrees and minutes thus ob-

tained, must be applied the correction written on the card, and the result will be the true magnetic position of the sun, from which, and the observed altitude, the variation of the needle may be obtained in the usual manner. When the variation is to be determined for the purpose of correcting the ship's course, it is sufficient, and indeed necessary, that the magnetic azimuth should be taken without any reference to the local attractions which may affect the needle; but for scientific deductions, after a certain number of observations have been obtained with the ship's head in one direction, she should be put on an opposite course, and another set of observations taken from the same spot: the mean of the two results will be the true variation of the needle.

The compass above described is also well calculated for surveying, for which indeed it was originally intended. To apply it to its purpose, nothing more is necessary than to slide the frame containing the segment of the glass cylinder to the top of the sight, when a hair will be seen, which must be made to bisect the object viewed by direct vision at the moment that its bearing is also read off by reflection.*

On approaching the Pole, the north end of the needle will incline downwards; but the card may again be readily balanced by taking out the ring and glass, and attaching a small bit of wax to the south part of the needle.

Of the Altitude Instrument.

The fogs which obscure the horizon in high northern latitudes, but through which the sun may yet continue visible,

* There is another mode of using this compass, which may perhaps be found more convenient and accurate than that which has been described. It is simply to turn back the reflecting sight, and to view the line of light, and read off the degrees by direct vision; and it has this decided advantage, that if the compass should not be in a horizontal position, the observer may readily perceive and correct the error. Great care, however, is necessary, not to mistake in reading the figures indicating the degrees, and this may be prevented by viewing them also by reflection.

render some contrivance necessary to take altitudes without reference to the horizon. For this purpose I thought of the following instrument, which may perhaps be found useful, if other methods fail. A small telescope with cross hairs, is fixed to a divided circle, about the centre of which a vernier moves, furnished with a tangent screw for slow motion; and at right angles to the arm which carries the vernier, a level is fixed. At the centre of the circle a mirror is placed, capable of being turned on its axis, so that the bubble of the level may be seen with the left eye, whilst the right is employed in looking at the sun. A lens is added to obtain distinct vision of the bubble.

To use this instrument, let the observer cover the centre of the sun with the cross wires, holding the circle vertical, and then turn the mirror till the bubble of the level is seen by reflection through the lens by the left eye, the level having been previously placed nearly horizontal. The vernier being clamped, the observer will bring the bubble of the level to the middle, by means of the tangent screw, the centre of the sun being at the same time on the cross wires.

It is not to be expected that the bubble should remain stationary, but fluctuate backwards and forwards; all that is required being, that it should not rest at either end of the level. The vernier is now to be read off, and the tangent screw being moved a little, the observation is to be repeated several times in like manner, and the mean of the whole taken.

The face of the instrument is now to be turned to the other side, and the observations repeated in this position, in order to remove any error of collimation. The mean of both results will be the apparent altitude of the sun's centre.

I must here caution the observer against expecting a near coincidence in his readings; for though the mean result may be hoped to be within three or four minutes of the truth, the coincidence of the readings, as well as the accuracy of the result, will depend principally on the steadiness with which the observer can keep the centre of the sun on the cross wires.

Of the Hydrometer.

The hydrometer is intended to determine the specific gravity of sea water in different latitudes. It consists of a ball having a small stem projecting from it, terminated by a cup, and on the opposite part of the ball is a weight sufficient to cause it to sink when immersed in distilled water of the temperature of 50° until a mark made on the stem is on the surface of the water. The weightof the hydrometer a little exceeds 1000 grains, consequently the weight of distilled water displaced by it will also be a 1000 grains. The box contains circular weights of 10, 20, 30, &c. grains, and in separate papers are weights of single grains and tenths. The tenths are made of wire, and their value may be known by the number of parts into which they are bent. The mahogany box is inclosed in a tin case, intended to contain the sea water.

To use the instrument, fill the tin vessel nearly with the sea water, and place the hydrometer in it. Carefully examine whether any bubbles of air are attached to the hydrometer, and if so, remove them with a hair pencil or feather. Place now weights on the cup sufficient to sink the hydrometer to the mark on the stem. In doing this, it will be necessary to force the ball of the hydrometer below the surface of the water by pressing on the cup. When the hydrometer is steady, observe whether the surface of the water round the stem is depressed or elevated; if the former, the weight is too great, if the latter, too small. Nothing more is necessary than to register the number of weights thus placed in the cup of the hydrometer, which added to 1000 will give the specific gravity required, and immediately afterwards to ascertain the temperature of the water by placing a thermometer in it. For this the thermometer attached to the portable barometer will be found convenient. The hydrometer should be carefully wiped previous to returning it into its case.

On the Use of some Instruments, by Dr. Wollaston.

The Dip-Micrometer.

Since the depression, or dip, of the visible horizon at sea, may differ from the computed dip, as given in tables constructed

for the use of seamen, the Dip-micrometer and Dip-sector have been contrived for the purpose of measuring the actual dip at the time of any observation.

In the Dip-micrometer, the eye-end of the telescope is turned at right angles to its length, in order that the observations may be made with greater convenience in opposite positions of the instrument.

The instrument being held in a vertical position, two opposite points of the horizon are seen by reflection through two lateral openings at the larger end. When the two images have been made to coincide by means of the tangent screw at bottom, the divided head of the micrometer must then be set to zero, and the observation must be repeated with the length of the instrument inverted. Since in one position the arc measured is 180° through the zenith, INCREASED by the dip of each horizon, and since in the opposite position of the instrument it measures the opposite arc through the nadir, or 180° DECREASED by the same double dip; hence, the difference of the two observations is really four times the dip; but in order to avoid the arithmetical operation of dividing by four, the divisions on the micrometer head are made larger in that proportion, so as to shew at once the actual dip without division.

The Dip-sector.

In the Dip-sector the eye-end of the telescope is set at right angles to the plane of the instrument, in order that the head of the observer may not intercept the view of that horizon, which is seen by reflection.

If the plane of the instrument be held truly in a vertical position, the opposite points of the horizon that are seen, will appear parallel to each other; but, on the contrary, they will appear to cross each other, if the plane of the instrument be inclined either to or from the observer: hence, this mark becomes a sure guide in giving a correct position to the instrument, which requires a little practice to effect.

The index is moved by a tangent screw, as in a common sextant; and when, by means of it, the two horizons have been brought to coincide, the place of the index is to be noted down

to minutes and seconds. But the observation is not complete without being repeated with the instrument inverted. If the index glass was held uppermost in the former position, the instrument then measured the arc through the zenith of 180°, increased by the dip of each horizon; but when the instrument is inverted, so that the index-glass is lowermost, then it measures the opposite arc through the nadir, or 180° decreased by the double dip. Hence, the difference of the two arcs is four times the dip; consequently, when the two horizons have again been made to coincide in the new position of the instrument, the place of the index is to be again noted down, and the difference of the two readings divided by four, shews the actual dip observed, without any regard to the index-error, which is purposely made considerable, in order to avoid any negative reading.

There is a screw for equalizing the light of the two horizons in the first observation; but in the second, there will be no occasion to move the screw, if the observer turns his face round to the opposite direction at the same time that he reverses the instrument, for then the same horizon, as before, is seen as reflected image.

Since the principal known cause of variation of the dip is a difference between the temperature of the sea and air, it would be desirable, as often as may be, to observe the state of the thermometer in the air, and also to ascertain the temperature of the sea, and to record them regularly whenever the dip observed is found to differ from that shewn in the common tables, with a view to perfecting future tables for the same purpose.

The Macrometer.

The macrometer is intended to measure directly the distance of inaccessible objects, by means of two reflectors, mounted as in a common sextant, but at a greater distance from each other.

The first reflector admits of adjustment by a capstan-headed screw, for the purpose of correcting lateral error of the images.

The index-glass does not admit of adjustment, but the index-error must be occasionally ascertained, as usual, by means of the sun or other celestial objects. And as the instrument is intended to be used solely in the vertical position, the index-error

should be examined as nearly as may be in the same position by measuring the diameter of the sun near the horizon.

When any terrestrial object at a moderate distance is observed, and its two images are made to coincide, the place of the index, corrected by the index error, being referred to in the following table, will shew the distance of the object in yards.

The measure depends on the angle which the interval between the mirrors subtends at the object observed; and if the interval of the mirrors (one yard and a half) be considered as radius, the distance is as cotangent of the angle measured.

′ ″	Yards.	′ ″	Yards.	′ ″	Yards	′ ″	Yards.	′ ″	Yards.	′	Yards.
0 10	30940	5 0	1030	10 0	515	20 0	258	30 0	172	45	114
20	15470	10	995	20	498	20	254	30	169	46	112
30	10313	20	965	40	482	40	249	31 0	166	47	110
40	7735	30	936	11 0	468	21 0	245	30	163	48	107
50	6188	40	908	20	454	20	241	32 0	161	49	105
1 0	5157	50	882	40	441	40	238	30	158	50	103
10	4420	6 0	858	12 0	430	22 0	234	33 0	156	51	101
20	3867	10	834	20	418	20	230	30	154	52	99
30	3438	20	813	40	407	40	227	34 0	151	53	97
40	3094	30	792	13 0	397	23 0	224	30	149	54	95
50	2813	40	772	20	387	20	221	35 0	147	55	93
2 0	2578	50	753	40	377	40	218	30	145	56	92
10	2380	7 0	735	14 0	368	24 0	214	36 0	143	57	90
20	2210	10	718	20	360	20	212	30	141	58	89
30	2063	20	702	40	352	40	209	37 0	139	59	87
40	1934	30	686	15 0	344	25 0	206	30	137	1° 0	86
50	1820	40	671	20	336	20	203	38 0	135	1	84
3 0	1719	50	657	40	329	40	201	30	134	2	83
10	1628	8 0	644	16 0	322	26 0	198	39 0	132	3	82
20	1545	10	630	20	315	20	196	30	130	4	80
30	1470	20	618	40	309	40	193	40 0	129	1° 5	79
40	1403	30	606	17 0	303	27 0	191	30	127	6	78
50	1341	40	594	20	298	20	189	41 0	125	7	77
4 0	1288	50	582	40	292	40	186	30	124	8	76
10	1236	9 0	571	18 0	287	28 0	184	42 0	122	9	75
20	1188	10	561	20	281	20	182	30	121	1° 10	74
30	1141	20	551	40	276	40	180	43 0	120	11	73
40	1103	30	541	19 0	271	29 0	178	30	118	12	72
50	1064	40	532	20	266	20	176	44 0	117	13	71
5 0	1030	50	523	40	262	40	174	30	116	14	70
		10 0	515	20 0	258	30 0	172	45 0	114	1° 15	69

Use of the Electrical Apparatus.—H. D.

The analogy of the Aurora Borealis and Australis to electrical light, strongly impresses on the mind the probability of these phenomena being electrical; and it becomes an interesting question, whether the earth may not possess electrical as well as magnetic poles. An electrical apparatus is furnished for each Expedition, in order to determine if there is any thing peculiar in the electricity of the atmosphere in the polar regions. The use of this apparatus must be obvious, from its simple construction: it consists of a chain of copper, attached by glass to a rope, by which it is to be elevated so as to be out of the reach of conductors, and as far as possible above the surface of the vessel and the water; the electrometers to which the chain is to be attached, are likewise insulated. The sphere of the balance is brought in contact with the brass ball when the instrument is to be used: the degree of repulsion will indicate the degree of electricity of the atmosphere.

When the ball is observed to be repelled, a stick of sealing wax is to be rubbed with woollen cloth, and presented to the brass ball; if the repulsion of the sphere of the balance ceases, or is diminished, the electricity is positive; if it be increased, the electricity is negative. The observation should be registered in a journal, and the experiments made at different times in the twenty-four hours; and the state of the weather, temperature of the barometer, clouds, &c. at the time, noted.

When the balance does not indicate electricity, the gold leaf electrometer may be tried. If the repulsion of the leaves is increased by rubbed sealing wax, the *electricity is negative;* if the contrary, the electricity is positive.

Use of the Apparatus for taking up Sea Water from given Depths.
H. D.

The possibility of reaching the Pole by the Expedition, must depend upon this circumstance, whether there is at the Pole an ocean so deep, that the heat stored up in it during the six months of summer, is sufficient to prevent the formation of ice

upon it in winter. If there be such an ocean, the waters of it must greatly expand during summer, and the laws of the motion of the earth would tend to pour them through the narrow seas or channels, separating Asia from America, and Spitsbergen from Greenland. If a current is found, it will consequently be of great importance to ascertain if the great body of it be comparatively fresh, or salt; and for this purpose the deeper parts of it should be examined, for snow or ice water may float at the surface, and salt water be beneath.

The Apparatus sent with the Expedition, consists of a copper vessel furnished with a stop-cock, which is opened by a piston moving in consequence of the compression of air when the instrument is sunk in the sea. The piston may be set so as to collect the water from five to eighty fathoms. As the volume f elastic fluids are inversely as their compressing weights, and as the compression of about thirty-two feet of water diminishes the volume of air to one-half, the gradation will point out the use of the instrument. It is needless to say, that the temperature of the water as well as all other circumstances should be registered.

If the current be ice cold, and comparatively fresh, there can be little hope of reaching a deep sea in that direction.

Of the state of the Atmosphere in high northern Regions.—H. D.

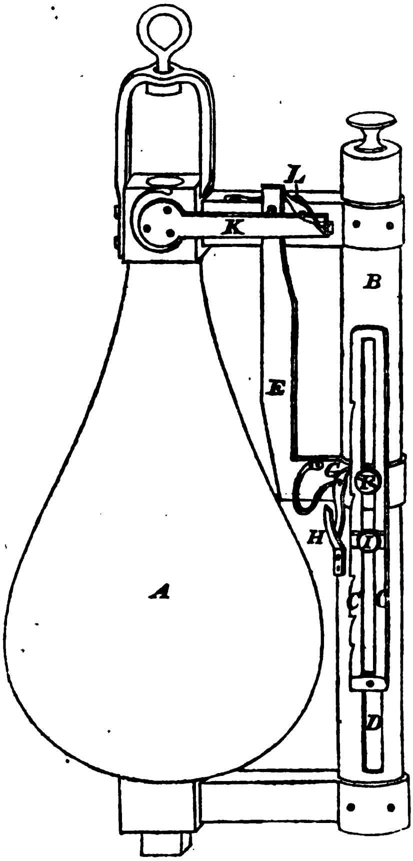
As there can be little or no change from vegetable or animal life or decomposition in the polar atmosphere, it will be interesting to ascertain the relative proportions of oxygene, azote, and carbonic acid in the air, as well as the nature of the air expelled from sea water. An apparatus for the analysis of air is sent with the Expedition. The use of it is so simple, that a description of it is unnecessary.

Use of Sir Henry Englefield's Barometer.

When you arrive at the place of observation, place the stand on your foot, with the feet upwards; open the lid, by the lock and ketches; take out the cistern, with its gage, and put them in the right pocket, then turn the ketch that holds the bottom of the box to the sides; shut the lid, and secure it by one ketch; then open the back, and take out the tube which has the suspension piece and scale, which hold under the left arm, leaving the remainder of the tubes secure. Detach the lid and place the feet on the ground, spreading them as much as may be necessary; pull out the gimball at the top of the stand: take the bottle of mercury and unscrew the funnel; take out the cork, which put in the pocket, and replace the funnel. Now place the tube in the left hand with the thumb upwards about an inch from the open end; then take the body of the bottle in the right hand, the thumb resting on the funnel, and even with its small end. Now, holding the knuckle of the fore-finger upwards, apply the end of the funnel to the aperture of the tube, the end of the thumb touching it at the same time. Now lift up the body of the bottle, the end of the thumb forming the centre of motion, and pour the mercury into the tube until it reaches to about a quarter of an inch of the end; then put down the bottle and put the cistern on to the end of the tube, pushing it as far as it will go. With the right hand take hold of the glass tube about an inch from the cistern, and with the left lift up the other end to an angle of about 45°, and you will perceive a large bubble of air passing up the tube and collecting all the small ones that were lodged there whilst pouring in the mercury. When the bubble has arrived at the top, gently reverse the position of the tube (turning it half round,) and it will collect the remaining air bubbles. This operation may be performed two or three times for greater security: Now, holding the tube in the left hand near the cistern, take it from the tube, and pour in a little more mercury until the tube is quite full, and replace the gage and cistern, pressing it firmly against

the end of the tube. Now hang the tube by the suspension piece in the gimball of the stand, and lifting up the gage with the left, pour mercury into the cistern until it forms a circle therein. (The bottle being taken care of either by putting it in a safe place, or replacing the cork.) Take hold of the glass tube about an inch above the cistern with the left, and with the right gently detach it a little from the tube with a screwing motion until the gage, which now floats on the mercury, coincides with the circle on the glass. Now set the scale to coincide with the inches between which the mercury stands, and read off carefully by the vernier in the usual way. The observation being completed and registered, in order to replace the barometer for a removal, take the tube from the gimball with the left hand, and taking hold of the cistern by the right, gently incline the tube until the mercury entirely fills the top, at which time push up the cistern against the open end of the tube, which may now be held vertical. Take hold of the tube with the left hand about a foot from the cistern, the forefinger pointing upwards, while the cistern rests against the arm just by the elbow, and resting on it. Then lift up the gage, to be held by the left hand; while with the right you take the bottle (divested of the cork and funnel), and apply the mouth of it and the end of the thumb to the edge of the open part of the cistern. Now, by gently inclining the glass tube, the mercury may be poured from the cistern into the bottle, which put down, and hold the tube in the left hand with the cistern upwards, which take from the tube. Now with the right hand apply the mouth of the bottle to the end of the glass tube, and turn it up so that the end may enter the bottle; hold the tube vertical, and the mercury will run out. Replace every thing as before.

Art. III. ***Description of the Apparatus, alluded to in the foregoing Paper, for bringing up Water from certain depths in the Sea.***



A is the bottle. B is a cylinder 12 inches long, and 1 in internal diameter; it is open below, but made tight above by a screw; a piston works in this tube, and at common atmospheric pressure includes a space of 6 inches between its internal surface and the top of the tube. A rod passes downwards from the under surface of the piston to the length of about 5 inches, and is then connected with the piece C by a

cross bar, passing through the aperture D, so that C is in fact a prolongation of the piston rod; and as D is an opening in the tube which extends nearly half way up it, a motion of the piston and the affixed part is allowed to that extent. E is an arm sliding freely upon the cylinder. F is a screw fixed into it, which steadies, but does not bind the piece C. G is a click, or small lever, which is pressed by the bent spring on the outside against the edge of C and catches in the notches, when any one of them comes opposite to it. H is a small inclined plane which acts on the lower arm of the lever G. I is a piece which may be fixed on any part of C by the thumb screw, and when sufficiently raised, it comes in contact with the socket of the arm E. K is a lever attached to the plug of the cock; there is a spiral spring fixed round it at the head of the bottle, which constantly tends to throw it up and open the orifice. L is a second click or lever, which is pressed by a spring towards a horizontal position; its lower arm catches on a pin projecting from the end of the lever K, and keeps it down, the other end moves against the edge of the arm E. The cylinder is retained firmly in its place by two pieces passing from the top and bottom of the bottle. There is a square-headed screw in the bottom of the bottle, which, when removed, lets out the water: and the whole is slung in gimbles, to which the rope is made fast.—The action of the apparatus is as follows:—When the piston rises in the cylinder, it elevates the rod and the piece I; this coming against the socket of E, lifts the whole arm, and the inclined edge above acting on the end of the lever L, sets it off from the notch of the arm K, which rising, the bottle is opened, and water may enter. When the piston falls again, the click G catches in a notch on the edge of C, (these notches being made at proper intervals) and the arm E is in consequence brought down by means of the pin in its upper end; it depresses the lever K, and brings it within the click L, so that it is again retained its first position; and the moment this is done, the parts are so adapted to each other, that the inclined plane H, presses upon the end of the click G, and when it has descended a very little further, C is intirely liberated from the notch in which

it had caught, and the arm E is left unattached. If the piston descends lower, it carries the piece C down with it, but does not affect any other part.—When the parts are adjusted to each other, a scale is marked off on C, the various points of which coincide with one, two, three, and more atmospheres; and the piece I being set at these points, liberates the lever K at the moment those pressures are obtained; so that the whole being thrown into water, as it sinks, the pressure of the column of water above is exerted on the piston, and opens the bottle at the precise depth for which the piece I had been previously set.

The instrument was made under the direction of Sir H. Davy, by Mr. Newman, of Lisle-street.

Art IV. *Extract of a Letter from John Davy,* M. D. *to Sir H. Davy.*

Trincomale, Oct. 3, 1817.

My different excursions have been highly interesting. As soon as possible I shall give you a pretty minute account of the results of my observations. Now I must be very concise indeed. In July I went to the southern part of the island, and visited the districts of Matura and the Malagan-patton.—In the former, gems abound. I saw the natives at work in search of them in alluvial ground.—Here I ascertained that the native rock of the sapphire, ruby, cat's eye, and the different varieties of the zircon, is gneiss.—These minerals and cinnamon stone occur imbedded in this rock. In one place I found a great mass of rock, consisting almost entirely of zircon in a crystalline state, and deserving the name of the zircon rock. It is only a few miles distant from a rock called the cinnamon-stone rock, from its being chiefly composed of this mineral, in company with a little quartz and adularia. In the Malagan-patton, the most remarkable phenomena, and what I went chiefly to see, are the salt-lakes, the nature of which hitherto has been considered very mysterious, from the want of enquiry, which I was

able to make in a very short time, and ascertain the source of the salt. Many of these lakes are of great extent, and in a great measure formed by an embankment of sand thrown up by a heavy sea, along a level shore. The water, that falls in torrents during the rainy season, is thus confined, and inundates a great part of the country; the sea, more or less, breaks over or percolates through the sand-banks, and thus the water is rendered brackish.—In the dry season the wind is very strong, and dry, and the air very hot; it was from 85° to 90° when I was there. The consequence is a very rapid evaporation of the water—the drying of the shallow lakes—and the formation of salt. It is from these lakes chiefly that the island is supplied with salt. The revenue that this one article brings Government, amounts to about £10,000. annually. The Malagan-patton altogether is a singular country; its woods, and it is almost all wooded, are principally composed of euphorbia and mimosæ:—its few inhabitants are a sickly race, miasmata destroying their health, and the wild animals, with which the country abounds, as elephants, hogs, deer of different kinds, leopards, bears, &c. destroying the fruits of their labour. In the beginning of January I attended the Governor and Lady Brownrigg to Kandy, and had a good opportunity of becoming acquainted with the manners of the natives. The country in the interior, and particularly round Kandy, is magnificent; its grand features are high hills and mountains, and deep vallies, and perpetual wood, and perennial verdure;—the wood is in faulty excess. The climate is fine; the air cool; generally at night below 75°, averaging all the year round the moderate temperature of 74°. From Kandy I made an excursion alone into Doombera, and explored a mountainous region, where a white man was never seen before.—My object was to examine a cave that yields nitre. It is a magnificent one in the side of a mountain, in the depths of a forest surrounded by mountains of great height and noble forms. I shall send you a particular account of this, and of other nitre caves I have visited. The rock is a mixture of quartz, felspar, mica, and talc, impregnated near the surface with nitre, nitrat of lime, and sulphate of mag-

nesia, and in one spot with alum, and in another incrusted with hydralite, similar to that round the Geyser, in Iceland. From the mountains of Dombera I looked down on the wooded plains of Birtanna, and saw the great lake of Birtanna, which no European I believe ever before visited; it is full of alligators. Returning to Kandy, after a short stay there I next came to this place, through a country almost entirely over-run with wood:—three days we travelled in a noble forest without seeing a single habitation. I wish you could see some of the noble ebony trees which flourish here, and without observing any traces of cultivation; but some fine remains of antiquity, especially about Candely lake, indicating that the country had once been in a very different state.

ART. V. *Translation of a Letter from a learned Foreigner to a Friend in this Couutry, on the Figure of the Earth, and on the Length of the Seconds Pendulum in different Latitudes.*

AT the present moment, when the philosophers of France and England are conjointly engaged in attempts to determine, with the utmost precision, the length of the second's pendulum in different latitudes, and the measure of the earth, you have thought that it would be not uninteresting to point out in a simple and popular manner, the exact object of these operations; what means are made use of in their execution; and lastly, what useful results are likely to be derived from them to science and society. Such is the object of the letter which I have the honour to address to you.

Although these questions ought naturally to be discussed in the order in which they are proposed above, which is regulated by their mutual dependance, it may perhaps be advisable first to touch slightly upon the latter, and to indicate what of great and profitable, such researches may have for the human mind. Those who are specially engaged in the cultivation of the

sciences, know well that the importance of a discovery ought not to be estimated solely by the direct and immediate use that can be made of it. A multitude of examples, or rather constant experience, demonstrates to them that every acquisition of knowledge sooner or later brings forth its fruits; and those discoveries which have the good fortune to be useful from their birth, such as vaccination, the safety-lamp, and the electric pile, are in their eyes favourable anticipations, which give them a right to appeal to futurity, and to obtain credit from their contemporaries for abstract researches, of which the practical consequences, though not less certain, are more distant, and less immediately apparent. But whatever confidence in their researches such memorable examples naturally inspire, they ought never to neglect to justify it, even by remote indications, whenever it is in their power. We have this advantage in the class of researches which constitute the object of this letter, and I shall not fail hereafter to point out all their important applications.

I think it right, now however, to premise, that the knowledge of the figure of the earth, the determination of its measure, and of the variation of its gravity upon different parts of its surface, are indispensable elements in the theory of universal gravitation; that they present so many confirmations of its truth of the first importance; that they serve to demonstrate the identity of terrestrial gravity, with that force which retains the moon in its orbit round the earth; that they only can discover to us if the density of the earth is equal throughout its mass, or whether it is different at different depths; and whether in every stratum at the same depth, this density is uniform, or variable at different points; and lastly, the precise determination of the dimensions of this globe which we inhabit, may enable us from its measure to form a fixed and universal standard of mensuration, whose subdivisions may be applied to the surveys of our fields, the measures of itinerary distances, and the construction of nautical and geographical charts, whilst its multiples may serve to express the vast extents of celestial space, which the astronomer has taught us to mea-

sure. It is this unit of mensuration, deduced from the measure of the earth, which has been called *meter* by the French philosophers.

It may be easily conceived that these beautiful deductions of science have not been obtained without immense labour. There is reason to believe that the ancient astronomers of Chaldea and Egypt acquired notions sufficiently exact concerning the magnitude of the globe, but their first attempts are far indeed removed from the minute precision of modern astronomy. We are now certain of not making an error of 600 meters (about 300 toises,) in the calculation of the mean radius of the earth, which exceeds 6,000,000 meters. This may seem incredible to those who are not acquainted with the means made use of by astronomers, but nothing can appear more simple or certain when they are examined. Without entering into technical details, it is easy to explain the possibility of such precision. It will suffice for this purpose to remark, that the surface of the earth is not in fact so irregular as appears at first sight. That the mountains with which it is bristled, and the vallies with which it is furrowed, are, in proportion to its mass, no more than nearly imperceptible wrinkles, and that the little asperities upon the peel of an orange are comparatively much more considerable. If we also attend to the facts that the terrestrial continents are surrounded on every side by the sea, which penetrates them by numberless channels, that their coasts are no where much elevated above the waters which bathe them; that all the rivers by which these continents are divided, reach the ocean by very gentle declivities, since they are all commonly navigable; we shall perceive in this equilibrium the result of the general level of the terrestrial surface; we shall be able to conceive that its curvature must follow the regular curve of the ocean; and from thence we shall perceive that taking into the account, for greater exactness, the little undulations with which it is furrowed, the measure of such a curve may be accomplished with all the rigour of a mathematical operation.

Nothing more remains than to point out the processes by

which this measure is obtained. We have sometimes seen upon the sea-coast a vessel sailing from the shore; at first the whole is visible; but as it recedes it seems to sink into the horizon; the hull first disappears, then its lower sails, then the tops of its masts; and lastly, it totally vanishes. This arises from the convexity of the earth, which intervenes between the vessel and the spectator. At the same time, those who are on board observe a similar phenomenon. They first lose sight of the shore, then of the houses, then of the towers, then of the mountains, till at last they find themselves surrounded by the horizon of the sea. This progressive sinking, which they remark in receding from the shore, we may also perceive in the celestial constellations, in travelling upon the earth from north to south, or from south to north. The north pole and the stars which surround it sink towards the horizon as we advance to the south; on the contrary, it rises if we return. All the stars partake of these changes of elevation, which are caused only by our change of place. By measuring with care their meridian altitude above the horizon of each place, we ascertain the number of degrees this altitude has changed for the distance we have travelled on the same meridian; and as from the immense distance of the stars all the visual rays which proceed from them to every point of the earth at the same instant form no appreciable angle, it follows that the angle so observed, is really nothing but the mutual inclination of the horizons of the two places to which the observer has transported himself upon the same meridian, or in other words, it is the angle comprised between the vertical drawn in these two places perpendicularly to the surface of the earth. If then we measure also the distance of the two stations upon this same surface, by means of a determined standard of length, which may, for instance, be the toise, we shall know that in the part of the earth where the observation is made, such an angle between the two verticals answers to such a number of toises; so by simple proportion, we deduce the number of toises which correspond to an angle of one degree. This is what astronomers call measuring a degree of the meridian.

Now, suppose that we repeat the same operation upon different parts of the same meridian; for example, in England, in France, and upon the coast of Guinea: if the earth be exactly spherical, each meridian will be a circle, of which the terrestrial verticals will be so many radii. In this case, to find an angle of one degree between two successive verticals, it will be necessary to traverse an equal length of arc; that is to say, to advance upon the same meridian, from north to south, or from south to north, an equal number of toises. But if certain parts of the meridian be flatter, and others more convex, this equality will no longer exist; in that part where the curvature is more flat, it will be necessary to proceed further before we compass an angle of one degree between the verticals of the extreme stations, and where the curvature is more convex, not so far. Thus we can judge of the flatness or convexity of each part of the meridian by such comparisons. Now in making the experiment, we find that the terrestrial degrees are the shortest possible at the equator, and the longest near the poles, and that they go on gradually expanding from one of these limits to the other, as upon an elliptic curve; at least when the comparison is made between places sufficiently distant to prevent the law of the variation of the degrees, which is very gradual, from being confounded with unavoidable errors of the observation. From hence the conclusion has been drawn, and with reason, that the terrestrial meridians are ellipses slightly flattened at the poles, and protruding at the equator; and further, by repeating the experiment upon different meridians, it has been ascertained that the absolute lengths of the degrees at equal distances from the equator, differ insensibly, or at least so little, that the observations hitherto made have been insufficient to establish any decided difference.* From this equality also it has been

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* The degree measured by Lacaille, at the Cape of Good Hope, would alone seem to offer some probability of difference in the degree of flattening in the northern and southern hemispheres; but this difference being confirmed neither by the experiments upon the pendulum, nor by the amount of mean compression deduced

concluded, that all the terrestrial meridians have exactly, or very nearly, the same form, and are nothing more than the repetition of the same ellipse turning round a straight line, drawn from one pole of the earth to the other; that is to say, that the earth is an ellipsoid of revolution, flattened at the poles and protruding at the equator; therefore the length of the degrees measured upon this ellipsoid, determine its absolute measure in parts of the same scale, consequently in toises, if a toise be the standard arc we made use of for the progressive measure of the degrees.

Thus then we perceive, that the two fundamental operations of this enquiry are the observation of the altitudes of the same star upon different points of the same meridian, and the distance of these two points measured upon the earth's surface, reduced by supposition to the level of the ocean. The altitude is taken by astronomical instruments, such as the zenith sector, or the repeating circle, whose precision is extreme. These observations are repeated many thousand times at each of the extreme points of the arc to be measured; not one only, but many stars are made use of, for the sake of multiplying opportunities of observation; and the mean of all the results at each station is taken, that the minute errors of which the observations are susceptible, may compensate one another, at least in part.

As to the itinerary length of the arc, it is measured in the same manner as we survey a field, or project a plan; that is to say, by laying down a principal line, which may serve as a base for the whole operation; next, by founding upon this base a series of triangles linked the one with the other, the general system of which extends itself from north to south, or from

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from the theory of the moon, ought to be considered as very doubtful. For this reason, it is much to be desired, that the experiment should be again made of measuring an arc of the meridian at the Cape. This would perhaps be the most useful operation to astronomy that it would be possible to undertake at the present day.

south to north, in the direction of the meridional line which it is required to trace. The angle formed by this meridian with the first side of the chain of triangles is then measured, and by prolonging it in idea across their system, the rules of trigonometry are sufficient to determine all the points where it intersects them, and to calculate the different portions of its length, which are included between their sides. In general, the measure of an arc of the meridian differs in nothing from a survey, but by the magnitude of the triangles and the number of the bases. These are commonly measured in different parts of the system of triangles, for the sake of verifying the whole by computing the one from the other; and lastly, by the extremes of exactness and precision in the operations. Here, as in other parts of astronomy, there have been many attempts of antient date; but positive results have only been derived from modern operations. The first measure of a terrestrial degree, sufficiently exact to have been made use of, was taken in 1670, by Picard, an expert French astronomer. This furnished Newton with the true dimensions of the earth, which were necessary to prove whether terrestrial gravity extended to the distance of the moon, and diminished in the proportion of the square of the distance, was sufficient to retain that planet in its course round the earth, and to balance the projectile force of its motion, which tends unceasingly to carry it in a straight line from its actual direction. In fact, the experiments of Huygens upon pendulums had determined with great precision the force of gravity upon the surface of the earth, which is measured by the space described by heavy bodies in the first second of time when they fall freely towards that surface. This space is about 181 inches of the ancient measure of France. If it were true, as Newton suspected, that the same force of gravity extended itself to the moon, it would only be required to diminish these 181 inches in the proportion of the square of the distances of the centre of the earth to its surface and to the body of the moon, and then to see if this length, so reduced, would be equal to the augmentation of distance which the projectile force of the motion of the moon tends to impress upon

this planet in the same space of time. Now this last effect, which depends upon the quickness of the rotatory motion, may be calculated by the laws of mechanics from the duration of its revolution, and its distance from the earth expressed in inches or feet, that is to say in part of the same standard in which the fall of bodies is expressed above. At the time when Newton first attempted to prove this proposition, it was known that the mean distance of the moon was about sixty times the radius of the earth. But the length of this radius in feet or inches was still wanting and he was only in possession of a defective calculation of it. In introducing this into his calculation, he did not find the coincidence which he sought, and supposing that some unknown power was combined with terrestrial gravity in influencing the moon, he abandoned his idea. Fortunately, some years after he became acquainted with the new measure of Picard, and resuming his calculation with the data with which it furnished him, he established the important fact, which he had before suspected. From this law he found that a body falling *in vacuo* towards the earth, would describe an ellipse, of which the earth would be one of the foci. From the observations of Kepler, it follows that the planets also describe ellipses in their revolutions round the sun, which is placed in one of their foci; and the force which retains them in their orbits round him, follows the same law of decrease as gravity. Such was the conclusion of Newton. In following it to its most remote consequences with the most indefatigable power of genius, he found that it extended itself to every particle of matter, and that all particles, when placed at sensible distances from one another, attract each other in direct proportion to their masses, and in inverse proportion to the squares of their distances. It is in this that consists the principle of universal gravitation; and one sees by this process that this principle is not a fragile hypothesis, but a necessary and mathematical deduction from observed facts.

In applying this to the aggregations of the particles of matter which compose the earth and the planets, and considering these masses as having been formerly in a state of fluidity, turning upon their axes, and retaining their original forms when they

have become solid; which agrees with the fact Newton found, that they ought all to be swelled out at the equator, and flattened at the poles; their greater or less degree of compression depending upon their more or less rapid rotatory motion, and upon the laws by which their density varies from the centre to the circumference. In fact, if such a mass were motionless, and did not turn upon its axis, the mutual attraction of all its parts would unite together at equal distances from its centre all the particles of equal density, and the whole mass would be arranged in spherical concentric layers, round a common centre. But supposing such a mass turn around one of its diameters, the centrifugal force which would result, would produce upon its particles the same effect as rotatory motion produces upon the stone of a sling; that is to say, that it would tend to project them from the axis of rotation; and acting with greatest energy upon those which are most distant from this axis, because their motion is most rapid, it would raise them up: so that the columns of fluids situated in this part of the planet would swell themselves out at the expense of those at the poles, to compensate by their length the diminution of their weights.

If this were the only effect, it would be very easily calculated; but at the same time that the fluid mass quits the spherical form, the attraction which it exerts upon the points of its own surface changes, and the state in which it fixes itself, is that in which all the parts which compose it, may preserve a permanent position under the combined influence of their mutual attraction, and of the centrifugal force. This reaction of form upon attraction, and of attraction upon form, is precisely what renders the figure of equilibrium of the planets very difficult to determine. Newton solved the problem in the case where the fluid mass is homogeneous in all its parts. In applying the solution to the particular case of the earth, that is to say, taking as data the length to the terrestrial radius, as deduced from the measure of Picard, the force of gravitation calculated from observations of the second's pendulum, and the time of rotation drawn from the length of the sydereal day, he found that it ought to have the form of an ellipsoid of revolu-

tion, flattened at the Poles, and projecting at the Equator; whose lesser axis ought to be to the greater in the proportion of 230 to 231, so that the difference between the two axes, ought to be $\frac{1}{230}$ of the lesser. This fraction is what is called the compression of the ellipsoid. Newton further found, that gravity ought to vary upon different parts of this ellipsoid, and to go on increasing in intensity from the Equator to the Poles, in proportion to the square of the sine of the latitude; from whence it follows, that bodies ought to fall with greater rapidity, as we transport them from the first of these limits to the second, in the proportion that we have named.

This phenomenon had in effect been observed in 1672, by Richer, a French astronomer. Having carried an astronomical clock from Paris to Cayenne, he perceived, that without having experienced any apparent alteration, it went slower than its first rate at Cayenne by 148 seconds per day. The influence therefore of gravity upon the pendulum which governed it, seemed to have become weaker. To compensate this effect, it became necessary to shorten the pendulum in a sensible degree. Richer continued to observe it in this way for ten whole months; then having reconveyed it to Paris, and compared it with the known length of the pendulum in that city, he found it shorter by a line and a quarter. This was the counter-proof of the first experiment. All the observations made since by analogous methods in different parts of the earth, have confirmed these important results. We have seen, that the theory of gravitation points out its cause, and assigns its amount. Newton, in his Principia, has given a table founded upon this theory, in which the variations of the second's pendulum are calculated for all latitudes, upon the supposition of the homogeneous structure of the earth. The variations really observed by Richer and other astronomers, although differing very little from this table, are decidedly greater. From hence Newton concluded, that the compression of the earth is also more than $\frac{1}{230}$, which agrees with the supposition of homogeneous structure. But this was an error. Clairault resuming this difficult problem in his excellent work upon the figure of the earth, demonstrated, that the contrary is the case, and succeeded in

establishing these two propositions: 1st, that in every planet which has formerly been in a state of fluidity, and which is not homogeneous in its structure, the compression ought to be less than on the supposition of homogeneous composition, and the variation of gravity, as measured by the length of the second's pendulum, ought to be greater. 2udly, As much as the compression shall be below $\frac{1}{230}$, so much the whole variation of the length of the second's pendulum, from the Equator to the Pole, will exceed the same fraction. From this theorem of Clairault we perceive, that the compression of the earth may be inferred, as well from the observation of the lengths of the pendulum, as from the measure of degrees; and this is the reason why both processes have been employed in the great European arc, which extends at this day from Formentera, the most southern of the Pithian isles, to Unst, the most northern of the Shetland isles.

But this connection not having been sufficiently known in the days of Newton, doubts may still exist for some years upon the amount of the compression of the earth, or even upon its reality. A new measure of the meridian made in France, from Dunkirk to the Pyrenees, afforded degrees, which increased in length in proceeding to the north, which would seem to give to the earth a form lengthened in this direction. But the differences of these degrees were so small, that they could not by any means be established by the observations of that time, as their errors might, with all the care in the world, have concealed the effect of the compression, or even have brought out a contrary conclusion. The only means of deciding these doubts were to measure two degrees of the meridian, at latitudes sufficiently distant to insure, that the inequality of their lengths, in whatever direction it might prove, should be too great to be attributed to errors of observation. Such was the object of the voyage which Bouguer, Godin, and Lacondamine made to the equator, as Commissioners of the Academy of Sciences, and which lasted from 1735 to 1744. At the same time another commission, composed of Clairault, Le Monnier, Maupertuis, Camers, and Outhier, went to perform the same operation under the polar circle. The results of these two scientific expeditions proved

incontestibly, that the earth is really flattened at the poles. The degree of Lapland proved longer than that of Peru, by a quantity much too considerable to be reasonably attributed to uncertainty of observation. Nevertheless, the compression calculated from these measures, still left reason to suspect, that one of them, at least, was not exact, for the amount of the result was more than is adapted even to the supposition of homogeneous structure, while from theory it ought, at most, to be equal to this term, if the earth were homogeneous, and less if it were not. This was also indicated by the observations of the second's pendulum, made by the two commissioners at Peru and Lapland, for they give as the measure of compression the fraction $\frac{1}{2\,\overline{7}\,\overline{9}}$, which differs but little from that which we find at the present day, from much more precise operations. A new measure of a degree in Lapland, made since by Mr. Swanberg, an able Swedish astronomer, has proved that the error was on this side, and reckoning from his conclusions, the compression calculated from the degrees measured at the polar circle, and at the equator, agree with the result of the experiments upon the pendulum. It is not improbable, that the error of the northern commission arose from a want of verification, arising from too great confidence in the instruments employed; while on the other hand, in the operations in Peru, Bouguer took infinite pains to study the faults of his apparatus, to enable him to correct them, or to prevent their effects by a happy choice of circumstances the most favourable to the observations; so that with instruments inferior in construction, but proved and rectified by his dexterity, he obtained results which can certainly only be affected by very trifling errors. In general, in such delicate operations, the most perfect instruments ought to be employed with distrust; and their very perfection may become a snare to him who trusts too implicitly to them.

The doubts of which I have been speaking, were not yet removed when the Academy of Sciences conceived the design and the hope of equalizing all the measures commonly employed in France by the introduction of a standard common to all the parts of that great kingdom. It was agreed on all hands that this standard, to be invariable, ought to be taken

from some natural phenomenon, and after having for some time balanced between the length of the second's pendulum, and the measure of the earth, the last was fixed upon. Such was the origin of those great geodetic operations which have been undertaken since 1790, by the French philosophers in France and Spain, and which now united with the operations of the same kind undertaken in England under the direction of Col. Mudge, will comprehend from Formentera to Unst, an arc of 22 terrestrial degrees, situated almost exactly under the same terrestrial meridian. The length of the second's pendulum has been measured at the same time as the degrees themselves throughout the whole extent of this great arc, with apparatus calculated to shew its smallest variations. I shall describe in another letter what there is remarkable in the processes by which these different kinds of observations have been made; I shall endeavour then to shew the degree of confidence to be placed in the conclusions derived from them; I shall point out with what certainty we may be enabled to derive a standard of universal and invariable measures from them; and I shall explain the reasons which have determined the French philosophers to choose this standard from the measure of the earth, rather than from the length of the simple pendulum.

I have the honour to be,

&c. &c. &c.

Note upon the knowledge which the antient Egyptians appear to have had of the Figure of the Earth.

[This note is extracted from an unpublished Memoir, which was honoured with a prize by the Academy of Inscriptions and Belles Lettres of the Institute of France. It was communicated by the Author himself, who is at this day a member of the Academy.]

In examining the antient system of measures made use of in Egypt, and in comparing it with the geography of that country, and with the dimensions of such monuments as are still in existence, we discover some traces of the attempts which have formerly been made by the Egyptians to acquire

a knowledge of the measure of the earth, and we can acquire some notion of the degree of exactness which they have been able to arrive at.

The schænus, a measure of length made use of amongst the Egyptians, contained 12000 cubits or 40 stadia of 300 cubits each. These stadia of 40 to the *schœnus* were, according to Pliny, those of which Eratosthenes made use. They were contained 252,000 times in the circumference of the earth, or 700 times in a degree. The Egyptian cubit, found upon the nilometer at Elephanta, was 0,527 parts of the meter. The schæne was therefore equal to 12000 times .527, or, 6324 meters; and the stadium, which was its 40th part, was equal to $\frac{6324}{40}$ or 158.1 metres. So that as the last was said to be contained 700 times in a degree, it follows, that the Egyptians gave to a degree a length equal to 700 times 158.1, or 110670 metres. According to the tables of M. Dehambre, the mean degree of Egypt, that is to say, between 24° and 31° of latitude is 110796 metres; the difference therefore is 126 metres, and is equivalent to an error of 4 seconds in latitude. The Egyptians, therefore, had acquired a knowledge of the terrestrial degree within 4 or 5 seconds, that is to say, $\frac{1}{900}$ or $\frac{1}{1000}$ part, and nearly of its real quantity.

If we now apply to the territory, the measure in schæni or in stadia, which the antients prescribed to Egypt; we shall find that that country must have been trigonometrically surveyed with sufficient exactness. In fact, such of the partial distances by means of which the antients, and amongst others, Herodotus, have given the complete length of Egypt, are nearly taken in a straight line; so that modern observations give to Egypt between Pelusis and Sienna, a length of 7° 38′ 15,″ while the antient measures prescribe to the same interval a distance of 7° 37′ 7,″ the difference being 1′ 8″, or about $\frac{1}{400}$. How did the Egyptians arrive at such a degree of precision? It is not known. We are at liberty, however, to review the means which they had at their disposal. All antiquity attests, and the nature of their country demonstrates, that they were often under the necessity of recommencing the division of their lands. The multiude of operations supplying

what was wanting on the side of precision, they might arrive, after the lapse of ages, at a sufficiently exact knowledge of the measure of their country. Moreover, they knew how to draw a meridian line, as the placing of the faces of the great pyramid to the four cardinal points, sufficiently proves. They were therefore competent to take the azimuth of a triangle. Lastly, they knew how to make use of the gnomon; and after their taste for every thing colossal, there is no doubt but that they erected some very large ones, which might have given the proportion of the shadows with so much the more exactness, as it was possible to multiply and combine observations. Nothing more is wanting, to find with all the precision that the Egyptians have attained to; 1st, the difference in latitude of two points; 2dly. their distance expressed in the measure of the country.

ART. VI. *Experiments and Observations relative to Vision; by Marshall Hall, M. D. of Nottingham, formerly Senior President of the Royal Medical Society of Edinburgh.*

THE following detail is nearly confined to a series of observations and experiments made by myself. I have been induced to adopt this plan partly from the difficulty of meeting with persons sufficiently interested in their results to prosecute experiments at once nice and difficult in themselves, and requiring a certain degree of the power and habit of abstraction, for their performance; but principally from a peculiarity in my own vision, by which I am enabled to give the subject of this paper a peculiar illustration.

The peculiarity of vision to which I allude, consists in an ability to adapt the *left* eye for distinct vision at shorter distances than the *right*, and in an incapacity for adapting the *left* eye for distinct vision at great distances, whilst the *right* eye possesses the power of adaptation for distinct vision at very considerable distances. The nearest distance at which a

bright point is distinctly seen by the right eye is 4½ inches; but by the left eye the point is seen with perfect distinctness at the distance of 3½ inches. The same point is seen distinctly by the right eye at the distance of 17 inches; by the left it is seen indistinctly at any distance beyond 14 inches. With the right eye I distinguish each small branch and each leaf on a tree planted about thirty yards from my window; with the left eye these objects are seen in the most indistinct and confused manner. A distant light seen distinctly, or as a point nearly by the right eye, appears magnified into a large star to the left. The distant object seen thus indistinctly by the left eye, immediately acquires distinctness by the use of a concave lens.

A number of experiments have convinced me that, in myself at least, ordinary vision is performed principally by one eye alone, the left eye being chiefly employed and adapted for distinct vision at short, and the right eye, at long distances; whilst the axis of the other eye is merely directed to the object, in order to prevent the confusion and double vision which would arise from the different direction of the two eyes. In proof of this observation I may observe, that when the eyes are directed to a distant object, as the tree before my window just mentioned, any *intervening* object, placed within certain limits with respect to distance, and seen of course double, appears *indistinct* to the *right* eye, but perfectly *distinct* and with a well defined outline, to the *left*. On the contrary, when the characters on a printed page placed at the distance of about eight inches from the eye, are observed, whilst the point of a pen-knife placed at the distance of six inches is seen single and distinctly by both eyes, each word and line is of course seen double, and the *right* part of the double image, or that seen by the *right* eye, appears distinct, whilst the *left* side of this image, or that arising from vision by the *left* eye, is seen indistinctly and obscurely.

When the eyes are fixed on a distant object, and an intervening object placed also at a considerable, although at less distance, is observed, it is seen nearly distinctly by the *right* eye, and less distinctly by the *left*; and there is a particular

intervening distance at which it is seen equally indistinctly by both eyes. The same remark applies, *mutatis mutandis,* to the experiment in which the characters of a printed page are placed at the distance of eight inches from the eyes, and observed whilst the eyes are fixed for single and distinct vision at a shorter distance; if the less distance be nearly eight inches, the characters of the printed page placed beyond it, are seen either almost distinctly by the *left* eye, or equally indistinctly by both eyes.

These remarks appear to show that, in myself, as the right eye is endowed with a longer, and the left with a shorter sight, so in observing near or distant objects, the left or the right eye is principally employed, and most adapted for distinct vision, whilst the axis of the other eye is directed to the object, in order to obviate the double vision which would take place were this axis allowed to take any other direction; I may therefore be said to *look* at the object with both eyes, but to *examine* it with one only.

Having made this statement respecting the condition of my own eyes, and of their different capacity for adapting themselves for distinct vision at different distances, I now proceed to the detail of some experiments and of some cases of vision, in which the object is not only seen indistinctly and with an undefined margin, but also *fringed with the prismatic colours.*

In the first place I may observe, that in the cases of *indistinct vision* already described, if the object be opaque and well defined in itself, its borders are manifestly tinged by a decomposition of the rays of light. This fact observed in general in the observations and experiments already described, is evinced still more distinctly in the following manner.

If both eyes are fixed, adapted for single and distant vision, at the distance of eight feet, and if an intervening object *within* the distance of about six inches, or *beyond* that of about twenty inches, be glanced at, the latter object is seen indistinctly and bordered with the prismatic colours, by *both eyes*, but in a different degree and in a different manner by each. But if, in this experiment, the intervening object be

placed beyond the distance of *six* inches and *within* that of twenty, the *right* side of the double image, or that seen by the *left* eye, is distinct and free from colours; whilst the image induced by the impression of the light on the *right* eye, appears indistinct and fringed as before. By three other gentlemen, the more general observation has been made that, whilst the eyes remain adapted for the single and distinct vision of a more distant object, a nearer one, a word in capitals on a neatly printed page for instance, is observed to be bordered by the prismatic colours from a decomposition of the rays of light.

In these experiments a straight line on a printed page becomes doubled, presenting the appearance of two light blue lines inclosing a line or space of a brightish yellow colour; a dot becomes a small circle of light blue having a centre of yellow; an *o* becomes three concentric rings,—of blue, yellow, and blue; and if two *o*'s be viewed nearly together, as in the word GOOD, the light blue borders are seen to coalesce at the parts which approach each other, in the manner of two penumbræ, and to give origin to an appearance of a deeper blue.

These experiments have been diversified in the following manner. The eyes have been fixed on an object placed near them, so as to see it singly and distinctly. They have then been glanced towards another object, such as a word on a printed page, placed at a greater distance. The latter object is of course seen double; the *right* side of the double image, now induced by an impression made on the *right* eye, is distinct and free from colours; the *left* is indistinct and fringed with the prismatic rays. The three gentlemen before alluded to, observed the appearance of coloured fringes in general, whenever the eyes were adapted for distinct vision at a near distance, and glanced at a printed page or other proper object placed somewhat beyond the former.

Having thus ascertained that, when the eyes were glanced at a well defined object situated at a different distance from that at which they are at the moment adapted for distinct vision, whether *greater or less*, the rays of light are decomposed

in their passage to the retina; a set of experiments were next made by properly placing concave or convex lenses, or plane, convex, or concave mirrors, with respect to the eyes and the object viewed, so as to vary the degree of divergency of the rays proceeding from them. When the object is seen distinctly by the eye alone, it is seen indistinctly and fringed by the decomposition of the rays of light, when viewed by means of any of these instruments, the conformation of the eye remaining unchanged: and *vice versa*, when seen distinctly by means of any one of these instruments, it appears indistinct and coloured without them.

I have observed that in myself there is a certain distance with regard to each eye, and different for each, being *greater* for the *right* than for the left, at which an object cannot be made to appear fringed with colours by attempting to fix the vision at a point *beyond* it. Beyond this distance the margins of a small object cannot be seen distinctly by either eye; by the *left* they are seen indistinctly and slightly fringed with colours; with regard to the *right*, the distance alluded to is too great to allow of a small object being examined with sufficient minuteness.—There is in the same manner, a certain short distance with respect to each eye, and *less* for the *left* than for the *right*, at which an object cannot be made to display the fringe of prismatic colours by endeavouring to fix vision at a still smaller distance.—The distances just alluded to, are the *limits* of distinct vision for each eye respectively.

It would appear from this view of the subject, that whenever the eye is glanced at an object situated at a distance different from that at which the eyes are adapted for distinct vision, it produces the appearance of prismatic colours by decomposing the rays of light and leaving this dispersion without connection. In distinct vision, on the contrary, the decomposition of light appears to be accurately connected, so as to leave no appearance of prismatic colours. In distinct vision the eye appears to be perfectly achromatic; in the cases of indistinct vision which have been described, it appears to have lost its achromacy. What is the rationale of this phenomenon? Before

I offer any conjectures in reply to this question, I wish to make a brief statement of some additional observations on the subject in general.

It is well known that, *cæteris paribus*, the pupils are smaller when the eyes view an object placed at a near, than at a greater distance. This fact is also observed when the eyes are adapted for distinct vision at these distances respectively; and when an object at a greater or less distance, than that at which the eyes are fixed for distinct vision is glanced at, as in the preceding experiments, the conformation of the eyes remaining the same, not only is the mutual disposition and relation of the humours different, but the size of the pupil is also different from that which is proper to the eye when adapted for distinct vision at the distance of this object,—being less in the former and greater in the latter case.

This circumstance may have an influence in inducing an unconnected dispersion of light, as will be further noticed hereafter. At present I wish to add another remark which may be found to throw some light on the same point. An object is seen smaller by *one* eye than by *both*; in myself by the *right* than by the *left*; and it is seen smaller when the eyes are fixed for distinct vision at a distance *greater* or *less* than that at which the object is placed. In the first case the pupil is seen to become larger; in the second, the right eye is known to be of less refractive power; and in the two last instances both the size of the pupil and the conformation of the eye are changed,—the pupils being larger and the refractive power of the eyes less, in the former case, and the reverse in the latter.

From this view of the subject it would appear that a certain size of the pupils and a certain co-adaptation of the humours of the eye, are necessary for distinct vision, for securing the object viewed from a fringe of the prismatic colours, and for ensuring its due apparent magnitude. In further confirmation of this view some experiments were made with the application of the extract of belladonna to the eyes, the general result of which I proceed to state. The sight is

rendered larger, as has been stated by other experimentalists, and it is no longer perfectly achromatic:—a pen, for instance, cannot be mended at all, as indistinct and coloured vision is induced by bringing the object near enough to the eye to admit of its being seen distinctly in the ordinary state of the eye; but the eye is assisted by a convex lens, and a person naturally short-sighted is enabled for the time to dispense with the use of the concave glasses,—and the vision becomes distinct and free from colour partly on closing one eye, but still more on viewing the object placed even still nearer, through a small perforation in a card; but the indistinctness of vision and the dispersion of light are again induced by bringing the object viewed still nearer to the eye. Distant objects are also seen indistinctly and coloured, a dark coloured object having appeared to three persons who have performed this experiment, to have been tipt and fringed with purple.

There is a certain distance at which an object is seen tolerably distinctly with both eyes, under the influence of the belladonna; at a nearer distance the object appears indistinct and coloured to *both* eyes, but becomes distinct and colourless when viewed by *one* only; at a still nearer distance it is seen indistinctly and coloured by one eye, but becomes distinct and free from colour, on interposing a card perforated with a small hole.

The convex lens and the perforated card equally prevent indistinctness and dispersion, but on different principles; the former converging, and the latter excluding, the extreme rays of the pencil of light.

I am indebted for the repetition of some of the experiments with the extract of belladonna, which deserve to be further prosecuted, to Dr. J. Davy, and Dr. A. Fyfe; to whom, after an interval of five years, I now beg leave to return my best thanks for their friendly assistance.

After this detail of experiments, it may not be wrong to conclude this Paper by the following observations and queries, as they may induce other experimenters to prosecute the subject.

It is still a matter of dispute, whether the human eye be perfectly achromatic. If any dispersion of the rays of light

in their course to the retina, in ordinary vision, do in reality occur, it is in so limited a degree as to occasion no inconvenience. Those physiologists, therefore, who consult the *sense* alone, are of opinion, that the achromacy of the eye is perfect; and it has been attempted to explain this achromacy on the principle of the construction of the achromatic telescope, which, indeed, it is supposed to have suggested. But the idea that the humours of the eye are so co-adapted, that the dispersion produced by one is corrected by a contrary dispersion occasioned by the other, is probably erroneous. In the achromatic glasses, the dispersion induced, by a convex lens, is remedied by a similar but contrary dispersion effected by a concave lens; —or, at least, the *principle* thus stated is secured. In the construction of the eye, however, the rays, in their course to the retina, appear only to undergo *successive convergencies*, at least by *refraction*; and consequently the degree of dispersion is also augmented successively, at each transition of the rays of light from one humour to another.

There is a part of the eye, however, the action of which has not perhaps been *fully* ascertained.—The iris is supposed to regulate the quantity of light admitted to the retina, and in vision at near distances, to exclude those rays which would otherwise fall with too great obliquity on the crystalline lens. But are there not other effects of the iris, not sufficiently adverted to, in the inflection and dispersion of the rays of light at the edges of this part of the eye?—and may not these effects be similar to the operation of the concave lens, in the achromatic eye-glass? A small perforation in a card induces an inflexion and a dispersion of the rays of light which pass through it; may not the finely fringed edge of the iris induce these changes in a still greater degree? Those coloured rays of light which are most refrangible, are also the most inflectible. Now when the light is intense, or when any divergent rays of light strike the eye, and the eye is so conformed as to induce great convergency of the rays by refraction, and consequently, when the dispersion of the light must be great and very obvious, the pupil is then most contracted,

and the inflective and dispersive effect of the iris, greatest. May not this effect of the iris *counteract* the dispersion of the rays of light induced at their refraction by the humours of the eye? And may not this operation of the iris thus insure, in ordinary vision, the achromacy of the eye?

On this supposition we should conclude that whenever the disposition of the humours of the eye, and whenever the size of the pupil, was not in just proportion mutually and relatively to the intensity and direction of the rays of light, an unconnected dispersion of the rays of light would occur, and the eye would cease to be achromatic. Is not this in effect the case, in the experiments which have been detailed in this Paper, in which a manifest uncounteracted decomposition of the rays of light actually occurred?

Art. VII. *On Cryptogamous and Agamous Vegetation. From the French of* C. F. Brisseau Mirbel.

The subject of cryptogamous and agamous vegetation has been purposely reserved for a separate Section. The relation between the floral organs of this part of the vegetable creation, and those of the phænogamous part, has not yet been demonstrated in a way to justify the combination of the facts which belong to the one, into the same point of view with those which belong to the other.

In *cryptogamous* plants, the floral organs are extremely minute, of very distinct forms from those of *phænogamous* ones, and are often concealed from our sight by peculiar integuments.

In *agamous* plants, either there are no floral organs at all, or else they are of a nature that has eluded the research of the naturalist up to the present hour.

In the plants of this lower degree in the scale of organization in the vegetable creation, propagation is carried on by *suckers*, *bulbs*, *propagula*, and *seminula*. The two first modes being equally appropriate to the phænogamous plants, and familiar to

every one, do not require any particular notice in this place. The two last are those to which we shall here turn our attention.

Propagula are peculiar to the *agamous* division. They shew themselves in the form of a powder on the surface of the plant; are at no period enclosed within a germen; and have been deemed, with great appearance of probability, mere fragments of the external texture of the vegetable. The races of entire genera are continued by these means alone.

Seminula are common to both the *agamous* and *cryptogamous* divisions. They are minute organic bodies, which reproduce the species, and possibly differ from the seeds of the *phænogamous* division only in the smallness of their volume. Cryptogamous *seminula* are evolved from germens that form a constituent part of a real pistil. Agamous *seminula* are developed in *conceptacles*, a sort of germens, which having never formed any part of genuine pistils, offer no trace of either style or stigma. These diminutive seeds lie sometimes loose in the cavity of their conceptacles, or are at others confined several together in *elytræ*, a kind of partial conceptacles contained within a common one, which may be considered in this case as the involucre.

The term *agamous* is of very recent date. From the time of Camerarius, who first demonstrated the sexes of plants, down to a very late period, botanists were divided, into those who admitted the existence of sexes in no plant whatever, and into those who maintained that no species in the vegetable department of the creation was without them. Exclusive views, like these, have their rise in the tendency of the human mind, to draw general conclusions from partial facts, and which is ever the strongest in regard to those points, concerning which we know the least.

The philosophy of Linnæus was far from being untainted with prejudice, any more than that of so many others. Instead of sifting and discussing the theories of those who preceded him, he laid it down as an axiom, that the law of regeneration in vegetables was necessarily the same throughout the whole system. It was he that devised and brought into use the term *cryptoga-*

mous plants. He applied it indiscriminately to those species where he obtained some indistinct view of sexual organs, and to others where he never had the slightest glimpse of any. His doctrine was, that every organized being is endowed with the faculty of propagating itself either by egg or by seed; that an egg or a seed could not be produced without impregnation; and consequently, no organized being is destitute of male and female organs, though these may not be discernible by the eye of the observer. Subsequent investigations have however led to the opinion, that there do exist organized beings that produce neither egg or seed; and that others possess these means of multiplying themselves independently of previous impregnation; and most botanists of the present day agree, that the presence of sexual organs in many species included by Linnæus in his cryptogamous class of vegetables, is any thing but proved.

If we adopt the latter opinion, which appears to rest upon solid ground, it follows, that we should divide the vegetable system into three primary divisions, instead of two: the first, comprising the phænogamous species, where the process of fecundation is palpable; the second, the *cryptogamous* ones, where that process is involved in some degree of obscurity; the third, the *agamous* ones, in which no such process takes place.

Equal to the facility we may experience in forming a conception of three such classes in a general point of view, is the difficulty we shall find in determining the boundaries of each with precision. Experiment is undoubtedly the most direct test of the presence of the sexes. We can be at no loss concerning the office of the stamens, when we perceive that the ovula constantly miscarry in the most perfectly constituted germen, if the pollen has not reached the stigma; and on the other hand, find that the same as unfailingly come to perfection wherever the pollen arrives at the destined point.

A less direct test, but one that may be as safely depended upon, is analogy, and it is better suited to our daily purposes. We admit without hesitation, a multitude of plants into the ranks of the phænogamous species, upon which it has never entered our head to try any direct experiments in regard to the powers of

fecundation, being satisfied, by a comparison of the organization of their flowers with that of the few in which the existence of the sexes have been directly demonstrated, that we are entitled to acknowledge their being qualified with stamens and pistils. But in cases, where on one hand the analogy of the organs, grounded upon the similitude of forms, is not clear; on the other, the structure and the minuteness of the parts preclude the possibility of the test by experiment; it is easy to conceive, that the existence of the sexes may become a question; and this is what has actually taken place in regard to a good many plants, which have been ranked by each botanist, in his turn, according to his own particular views; at one time in the phænogamous, at another in the cryptogamous, at another in the agamous class. In this way opinions have become divided. One plant has been known to change its place as often as it has been examined. Another, after having been deposited by common assent, in one of the two classes of which we are now speaking, to this hour affords a handle for controversy, because it has not been possible to adduce strict proof of the office of each organ; hence it is, that both in the agamous and in the cryptogamous plants, the appellations of stamen, pistil, anther, germen, pollen, seed, propagulum, &c. &c., have been all applied in their turn to the same part in the same species by different botanists; and that systems. have gone on multiplying as fast as any fact in regard to organization, that had escaped preceding observers, has been brought forwards by succeeding ones.

If we give due weight to these circumstances, we shall be convinced, that a different line is to be pursued in reviewing the agamous and cryptogamous department of vegetation, from the one we have had to pursue in considering the phænogamous portion; for here our object cannot be to lay down general positions, and bring into one point of view all that belongs to each system of organs apart, because the forms are extremely various, and their functions, and of consequence their analogies, are more within the scope of conjecture than of demonstration. The method we have to pursue is to confine ourselves to the study of each group by itself, keep separate the facts which are

revealed by nature, from those which are to be found only in the conventional systems of man, and upon a final scrutiny, to abide by the doctrine which seems to afford the greatest degree of probability, without blinking the weak and hypothetical parts which may belong to it. We shall review in succession the *Salviniæ*, *Equisetaceæ*, *Musci*, *Hepaticæ*, *Lycopodiaceæ*, *Filices*, *Algæ*, *Lichenes*, *Hypoxyleæ*, and *Fungi*. In proceeding in this order, we pass by gradually changing shades of difference from the species which approach the nearest to phænogamous vegetation, to those which recede the farthest from it.

Before we enter into the detail of our subject, let us premise a few words concerning the texture of the substance of plants of this nature.

A membranous and cellular texture belongs to the substance of all plants, but subject to a vast variety of modifications, all which modifications are not found to exist in every species. We are acquainted, for instance, with certain phænogamous species, in which neither tracheæ, false tracheæ, nor moniliform vessels are to to be found. None of these modifications of texture belong to the mushrooms, liverworts, hypoxyleæ or algæ, which are most probably all of them of the agamous class. The substance of these consists of a mass of continuous cells of various elongations, with membranous walls of various thickness; and their outer skin or epidermis, which can seldom be detached from the rest of the texture, is without miliary glands. Excepting the algæ, the plants of this class have no parts of an herbaceous nature.

The other groups, viz. the Ferns, Lycopodiaceæ, Hepaticæ, Mosses, Horse-tails, and Salviniæ, do not appear to differ from those of the phænogamous class in the nature of their texture; leaves, or else herbaceous processes that serve the turn of leaves, and vessels, have been observed in the greatest part of them. Struck by this analogy to the phænogamous plants, some authors have concluded from thence, that the plants of these groups could not be without sex; not a very consequential way of reasoning at all events, since it is not yet proved that the presence of tracheæ, false tracheæ, miliary glands, leaves, &c. &c., necessarily imply that of stamens and pistils. Let us lay

aside all such groundless conclusions, and keep close to the detail of facts.

SALVINIÆ.

This group consists of the genera PILLULARIA (Pill-wort,) MARSILEA, SALVINIA, and ISOETES (Quill-wort,) all aquatic plants, which are to be found in France. We place it at the head of the ranks of the cryptogamous class, as other botanists have done before us.

PILLULALIA grows in wet places. Its creeping stem puts out small branches at different points; these produce slender cylindrical leaves, at first like a sheep-crook; at the foot of each branch arises a globular involucre, as large as a pea, without any opening; this involucre parts itself into four pieces, which then constitute four distinct cells, each containing from sixteen to twenty pistils, and from thirty to two-and-thirty anthers; the pistils are situated in the lower part of the cell, and have an obtuse stigma, the anthers are collected in a round tuft, and are suspended from the top of the same cell; these last are conical, and open transversely at the top; their pollen consists of globular grains, which do not burst when they come in contact with water; each pistil is provided with a seed that germinates by a leaf.

Linnæus, who had taken but a very superficial view of PILLULARIA, but was determined to find sexual organs in that as well as all other plants, supposed the involucre to be one entire pistil, containing several ovula, and that the pollen was disseminated over the leaves. But Bernard de Jussieu, by explaining the true structure of the sexual organs of this genus, has completely refuted the opinion of Linnæus. Nor can it be said that it was one founded upon observations of the least weight, or supported by any evident analogy; but stands a proof with how little circumspection even the most skillful authors make assertions in aid of any favourite system they have to build up. A reflection that will often obtrude itself into our minds, as we proceed.

MARSILEA has a stem which creeps along the ground, the same as in PILLULARIA; but here there are long petioles which

bear at their top four leaflets, disposed in the form of a cross, and near their base eggshaped involucres that do not open. The cavity of the involucres is divided lengthways into two cells, which are subdivided into several compartments, containing pistils and anthers mingled together. The anthers are very numerous and very small, do not open, have but one cell, and are filled with a pollen consisting of opaque grains; the pistils are not numerous; they are provided with a style, and contain within a double membrane, a granular transparent matter. This is the sum of what we collect from the observations of Bernard de Jussieu and Mr. Robert Brown; but in admitting that the facts stated by these skillful botanists are correct, yet the appellations of pistils, stamens, and pollen, may after all be misapplied, for experience has not yet taught the real uses of any of the organs of this genus.

Salvinia floats on and extends itself over the surface of stagnant waters, in the form of a lively verdant carpet. Its branches are furnished with small opposite oval leaves, sprinkled with minute glands surmounted by four spirally curled hairs; from under the pairs of leaves, and among the roots, are produced in groups several close globular involucres of about two centimetres in diameter. There is only one female involucre in each group; the rest are males, and contain from one to two hundred whitish globular anthers, each with a small filament of its own, by means of which the whole are collected in bunches upon a common shaft. The female involucre encloses from ten to twelve white oblong chagreened pedicled pistils, which become as many small capsular fruits, with one small seed (*seminulum*) in each. All these involucres separate from the parent plant towards the end of summer, and sink to the bottom of the water. In the following month of April, the capsules having rid themselves of the involucre, rise again to the surface of the water, and germination takes place. At first the capsule opens at the top by three teeth; then two radicles, like two little horns, are evolved; then a petioled leaf makes its appearance in the form of an inverted crescent; when the stem at last issues from the sinus in the leaf.

Linnæus had taken a false view of the sexual organs of Sal-

VINIA. Like Micheli, he took the male involucres for germens, the anthers for seeds, and the hairs on the leaves for stamens; but since his time, the organs of generation have been very carefully described in this genus by Guettard; and M. Vaucher has explained its mode of germination. But after all, the manner in which impregnation takes place in it is still a problem; and until this is solved, it behoves us to suspend our opinion concerning the stamens, and not to take for granted facts which have not been duly demonstrated.

ISOETES, Quill-wort, represents a fascicle of narrow elongated leaves. The base of the exterior one swells out and becomes an involucre, in which are enclosed one hundred pistils. Adanson asserts, that these pistils are accompanied by stamens; but Linnæus puts the stamens at the base of the interior leaves, and pretends that they consist of a scale surmounted by an one-celled anther. But all this is very obscure; and we can decide nothing concerning either the opinions of Linnæus or Adanson, without a fresh investigation of the parts of this genus.

We already find in this, the very foremost group, that the customary forms of the sexual organs of phænogamous plants have disappeared; and in fact, many botanists are of opinion, that all the plants that rank in it have neither pistils, stamens, or seeds. Necker, for instance, maintains that the involucres of PILLULARIA, MARSILEA, and SALVINIA, contain nothing but what he calls *Bésimeuces*, which he defines to be reproductive bodies, originally of a mucilaginous consistence, that become solid, and form themselves into a germen without the co-operation of impregnation. But still it is right that we should keep in our minds, that the involucres in PILLULARIA, MARSILEA, and SALVINIA, inclose bodies of two distinct kinds, and that Bernard de Jussieu has witnessed the transverse dehiscence of those which he considers as anthers.

To be continued.

Art. VIII. *Case of a Child aged six months, who swallowed a double-bladed Knife without Injury.*

Few subjects are more interesting, than the contemplation of the wonderful manner in which the human frame accommodates itself to the various violences to which it is subject: compression upon the brain; the effusion of fluids into the pericardium, thorax, and abdomen; a musquet ball or other extraneous body in the midst of muscle, &c.; all may remain a considerable length of time, without necessarily proving destructive: the human stomach is daily exposed to severe trials by the glutton and the drunkard, and daily it evinces its power of contending against such attacks, although it ultimately falls a sacrifice to their repetition or continuance.

If we are surprized at the efforts it is capable of in such instances, how much more must we wonder at those remarkable powers of adaptation by which it is sometimes enabled to remain uninjured when such substances as nails, pins, knives, &c. are swallowed by accident.

The painful and ridiculous feat of the Indian jugglers in passing a blunt piece of iron, under the name of a sword, into their stomach, which certainly contributes to render them short lived; and the instances we have of men actually swallowing knives to the number of 12 or 13, for a reward of spirits, or wine, do not come within the intention of these observations: they are meant chiefly to apply to those cases where foreign substances have been inadvertently swallowed.

In the Transactions of the Royal Society, cases are recorded, of knives being swallowed by adults, which forced their way through the coats of the stomach by producing inflammation, &c. or were removed by incision: we have also many histories of nails, padlocks, knives, &c. being swallowed without producing fatal consequences; but I am not aware of any case being recorded where a knife remained so *long* in the stomach of so *young* a child, as in that of which I now give the particulars, and which, on that account, deserves to be

preserved, if it has not already been communicated by the very respectable persons who, with myself, were witnesses to the facts.

CASE.

March 16th, 1802. A child of Jonathan White's, Southgate, Chichester, about *six months* old, had a small double-bladed knife, about two inches and a half in length, given it to play with. On the return of its mother to the room, she sought in vain for the knife, in all parts of the cradle in which the infant was lying: the child expressed some uneasiness at the stomach, from which the mother concluded it had swallowed the knife; the bowels were kept lax by the use of castor oil; and the fæces soon began to grow black. The child took no food, but milk; seemed often very uneasy in its stomach, and had slight febrile indisposition; yet it continued to look well, and was sufficiently fat.

May 24th. The shortest blade was discharged by the bowels; the back of it very much corroded, its edges being ragged, uneven, and saw-like: the rivet was entirely dissolved. The general state of the child's health, as stated above.

June 16th. The child after being for a day or two more than usually uneasy, and rejecting every thing offered as food, brought from its stomach, in vomiting, one side of the horn handle about two inches in length, very much softened and bent double: a small bit of iron was passed a few days afterwards by stool. He frequently expresses great pain in his stomach and bowels, and starts much when asleep; has retained no nourishment for three days, and now looks much emaciated.

July 8th. The child more emaciated, takes little food, and unless when quieted by a decoction of poppies expresses more pain, continually writhing. Its bowels are lax, and the stools have a black appearance, and the abdomen exhibits externally a degree of inflammation. His pulse is soft and moderate while asleep; the skin feels rough; has voided nothing since the horn handle.

July 24th. To day he passed a bit of iron, which was about

half an inch in length, of a wedge-like shape, much corroded, and full of holes, and appearing to have been the large blade.

August 11*th*. The child has been in a convalescent state for the last fortnight, grows fatter, and looks much better; has been more quiet, although he has not slept much; the decoction of poppies has been omitted for some time past; the pulse full and strong; sucks more heartily, and now eats sopped bread three or four times a day. Yesterday and to day it has been more uneasy: about five o'clock in the evening vomited up its milk, together with the back of the knife, 2½ inches in length, pointed, and corroded at one end; the *other* nearly perfect, and *first* presented itself at the mouth; soon after, it vomited the other side of the horn handle, softened, the edges uneven, and dissolved. The child was much exhausted by its efforts, and soon fell asleep. The stools are some days of their natural colour, and sometimes black.

Dec. 20*th*. The child is now in perfect health, remarkably robust, and has not experienced a day's illness since August.

The Notes from whence I have taken the above particulars were made at the moment by Mr. J. N. Shelley, now a surgeon in the army, who was at that period my senior, and whose observations I can corroborate most fully.

Whether we look on this Case, as proving the possibility of so large a substance as a knife remaining so many months without material injury, in the stomach of so young an infant, or whether we consider the state in which the separated parts of the knife, at distant intervals, came away, it affords equally curious and useful matter for contemplation. It shews the remarkable power possessed by the gastric juice, even in so young an infant, of acting upon the metal, by which the rivets of the knife and the sharp edges of it were dissolved, and the life of the individual saved.

Manifold are the precautions which the adult takes, to preserve his health and to guard against accidents; *he* is capable of explaining the nature of his sufferings, readily takes the most nauseous drugs to subdue disease, and submits to severe

pain to obviate the effects of accident; but the infant cannot describe its feelings, cannot be treated with certainty, and will not endure restraint to effect a cure of the consequences of accidents; how bountiful, then, is Providence, in guarding it from the accidents of birth, by rendering its bones flexible, in restoring union of fractures by the rapidity with which callus is secreted, and in enabling the stomach to meet so successfully, such calls upon the solvent powers of its juices, as are exemplified in this Case.

W. H. Banks, *Surgeon, Royal Navy.*

Ryde, Isle of Wight, May 8*th*. 1818.

Art. IX. *On the Production of Ice at the Bottoms of Rivers.*

The phænomenon of the production of ice at the bottoms of rivers, has been repeatedly noticed; but I am not aware that any satisfactory solution has hitherto been given of the cause. In Nicholson's Dictionary of Chemistry, several different hypotheses are enumerated, which I shall not now stop to examine; since it may be safely asserted, that they neither accord with the established principles of chemistry, nor with the facts for which they endeavour to account. The most recent theory with which I am acquainted, is that of Mr. A. Knight; who, in a Paper lately published in the Philosophical Transactions, seems to consider the particles of ice as originally formed at the surface, and afterwards absorbed by the eddies of streams to the bottom. He states in support of this idea, that he did not observe any similar appearance in *still* water. I shall advert to this hypothesis in the sequel; and, at present, it may suffice to remark of it and all others which I have hitherto seen, that supposing any of them to be correct, the same effects ought regularly to be produced, whenever the atmosphere is at a similar temperature; or in other words, that whenever the

frost is so intense as materially to affect the water of a river, we may then expect to find ice at the bottom. Now this is certainly not the case, since the appearance we are treating of never occurs but under peculiar *atmospherical* circumstances; and rivers are frequently frozen over, and remain so for a length of time, without a particle of ice being visible at the bottom of their streams. I do not now profess to have developed this mystery, but merely intend to state the circumstances under which the phænomenon commonly takes place, as well as a few particulars connected with it, which perhaps are not generally known, and which may hereafter be serviceable as data for investigating the cause.

It is well known to meteorologists, that a severe frost in winter does not always commence in an uniform manner. Sometimes it begins with a gentle wind from the E. or N. E. and is at first comparatively mild in its operations, but afterwards gradually increases in intensity. Frosts of this kind are generally more lasting than others, and during such, I have not observed that any ice is generated at the bottoms of streams; though the deep and still parts of rivers are often frozen over by them to a considerable extent. At other times, during the continuance of the violent south-westerly gales, which are so prevalent in this country in the winter months, the wind frequently shifts on a sudden from S.W. to N.W. commonly about an hour before sun-set, and blows with great impetuosity in this direction, attended with a severe frost, and sometimes with a heavy fall of snow. The effects of this frost in places exposed to the wind are extremely rapid, so as to render the ground impenetrably hard, in about a couple of hours from its commencement. Situations that are not so much exposed seem comparatively little affected; at least I have repeatedly observed, that a small sheltered pond in a field was nearly free from ice, while the current of a large and rapid river at no great distance was nearly choked up by it. I believe that the phænomenon under consideration seldom occurs, except during such frosts as these; and the following are the principal circumstances connected with it, which I am able to state from my own observation.

It may be here premised, that ice of this description is seldom seen adhering to anything besides rock, stone, or gravel; and that it is more abundantly produced in proportion to the greater magnitude and number of the stones composing the bed of the river, combined (as will be further noticed) with the velocity of the current. I have been informed by a friend, that he has occasionally perceived it attached to solid wooden piles, at a considerable depth beneath the surface of the water; but I never saw, or heard, of any on mud, earth or clay. It is not easy to ascertain the precise time at which the process begins to take place. It appears, however, almost invariably to commence during the first night of the frost, and probably within a few hours after sunset. On the ensuing morning, the first thing which strikes an observer is an immense quantity of detached plates of ice floating down the stream. Mr. Knight naturally enough supposed these to have been formed at the surface by the influence of the freezing atmosphere, and afterwards absorbed by the current: but I think that a minute inspection would have led him to form a contrary conclusion; *viz.* that they are first formed in the bed of the river, and afterwards rise to the surface. It is true, that none are to be seen in situations where there is no sensible current, and that they abound most in rough and rapid places. But on examining any stream of moderate velocity, yet smooth, equable, and free from all appearance of eddy or rippling, a great number of these plates of ice will be found adhering to the rock, stone, or gravel at the bottom. If they are watched with attention, they will visibly and rapidly increase in bulk; till at last, on account of their inferior specific gravity, aided perhaps by the action of the current, they detach themselves from the substances to which they at first adhered, and rise to the top of the water. The form of these pieces of ice is very irregular, depending, in a great measure, on the size and shape of the stones, or other substances, to which they were originally attached. Most of them seem to be of an oblong, or circular figure; they are generally convex on the upper surface, and have a number of thin laminæ and spicula shooting from them in various directions, especially from their circumference.

Sometimes, when these floating pieces or plates meet with any obstruction in the channel of the river, they accumulate in such quantities as to cover the surface of the water, and become frozen together in one large sheet. But this kind of ice may be always readily distinguished from that produced in the usual way by the action of the cold air on the surface, which is smooth, transparent, and of an uniform texture. On the contrary, one of these conglomerated fields or sheets, is opaque, uneven, full of asperities, and the form of each separate plate composing it may be distinctly traced. In this situation they commonly assume the shape of irregular polygons, with angles somewhat rounded; a form apparently caused by the lateral pressure of the contiguous pieces.

On the river Wharfe, near Otley, in the West Riding of Yorkshire, is a weir, or mill-dam, where this phenomenon is sometimes manifested in a striking manner. This structure is of hewn stone; forming a plane inclined at an angle of from 35° to 50°, fronting the north, and extending from W. to E. to the length of 250 or 300 yards. When one of the above-mentioned frosts occurs, the stone which composes the weir soon becomes encrusted with ice, which increases so rapidly in thickness, as in a short time to impede the course of the stream, that falls over it in a tolerably uniform sheet, and with considerable velocity: at the same time, the wind blowing strongly from the N. W. contributes to repel the water, and freeze such as adheres to the crust of ice when its surface comes nearly in contact with the air. The consequence is, that in a short time the current is entirely obstructed, and the superincumbent water forced to a higher level. But as the above-mentioned causes continue to act, the ice is also elevated by a perpetual aggregation of particles: till by a series of similar operations, an icy mound or barrier is formed, so high as to force the water over the opposite shore, and thus produce an apparent inundation. But in a short time the accumulated weight of a great many thousand cubic feet of water presses so strongly against the barrier, as to burst a passage through some weak part, through which the water escapes, and subsides to its

former level, leaving the singular appearance of a wall or rampart of ice three or four feet high, and about two feet in thickness, along the greatest part of the upper edge of the weir. The ice composing this barrier, where it adheres to the stone, is of a solid consistency, but the upper part consists of a multitude of thin laminæ or layers, resting upon each other in a confused manner, and at different degrees of inclination; their interstices being occupied by innumerable icy spiculæ, diverging and crossing each other in all directions. The whole mass much resembles in its texture the white and porous ice which may be seen at the edge of a pond or small rill, where the water has subsided during a frost.

It may be further observed, that a frost of this kind is very limited in its duration, seldom lasting more than thirty-six or forty hours. On the morning of the second day after its commencement, a visible relaxation takes place in the temperature of the atmosphere; usually before noon the wind on a sudden shifts to the S. W, and a rapid thaw comes on, frequently attended with rain. What appears somewhat remarkable, is, that during several hours after the commencement of the thaw, the production of ice at the bottom of rivers seems to go on without abatement; and upon examining a rapid stream, the stones over which it flows will be found at this period completely encrusted with the above description of icy plates. It seems evident from this that the bed of the river, which has been reduced below the freezing temperature, is not for some time affected by the change of the atmosphere. This may be in some measure illustrated by the well-known fact, that rain which falls upon a rock or stone-wall is frequently converted into ice, though the air and the ground are evidently in a state of thaw Before the following morning, the ice of which we have been speaking generally disappears, being carried away by the current, or dissolved by the thaw.

The last time that I remarked this phænomenon was in a stream of the river Air, near Bradford, in Yorkshire, on the 1st of January, 1814. This instance did not precisely accord with what I have stated to be the usual circumstances of the

case; as the frost then had existed several days without any previous appearance of this kind. But there were several indications of an approaching change of temperature; and the day following there was a partial thaw, attended with rain, the wind having veered from N. W. to S. W. This thaw, however, did not continue long, and was succeeded by a frost which surpassed all within my recollection, in severity and duration. Yet, during the whole of this period, though the thermometer frequently stood below 18° of Fahrenheit, and the estuary of the Tees, several miles below Stockton, where the spring tides rise from twelve to eighteen feet, was for more than two months frozen over, so as to allow the passage of a loaded waggon, I could never perceive a particle of ice adhering to the rock or gravel in the bed of the small and rapid river Leven, in Cleveland, where I then resided. This circumstance seems decisively to prove, that the phænomenon does not merely depend on intensity of cold.

I confess myself unable to frame any hypothesis respecting the above mentioned facts, which would not be liable to numerous and formidable objections. The immediate cause of the formation of the ice seems to be a rapid diminution of temperature in the stone or gravel in the bed of the river, connected with the sudden changes in the state of the atmosphere; but it does not seem very easy to explain the precise nature of this connection. We may easily conceive, that by a sudden change from a state of thaw to an intense frost, attended by a strong wind, the whole body of water in a river may become quickly cooled, and consequently diminish the temperature of the stone or gravel over which it flows: but to suppose that water, which is not itself at the freezing point, is capable of reducing the substances in contact with it, by means of a rapid and continual application of successive particles, so far *beneath* that temperature, as in process of time to convert the contiguous water to ice, seems not to accord very well with the usually received theory of the equilibrium of caloric. However, the fact that the quantity of ice thus produced is always greater in proportion to the superior

velocity of the stream, little or none being found where there is no sensible current, seems in some degree to countenance the above idea,

I cannot learn that any experiments have ever been instituted on this subject, though it seems that they might easily be made by a person conveniently situated, and possessed of the requisite instruments. A careful examination, by properly-contrived thermometers, of the relative temperatures of the air, the water, and the bed of the river, and of the changes undergone by them during the above process, would probably go a great way towards solving the problem. I know no one better qualified for this undertaking than Mr. Knight, if he should at any future period have leisure and opportunity to direct towards it the same acuteness of observation and accuracy of investigation which have enabled him to make such important discoveries in the œconomy of the vegetable kingdom. And, if the explanation of this phenomenon should ever lead to results of any importance to the cause of science, I shall feel sufficiently satisfied, if it be deemed that I have been of any service in pointing out the way.

RICHARD GARNETT.

Blackburn, Lancashire, May 16th, 1818.

ART. X. *On the Sounds produced by Flame in Tubes, &c. by* M. Faraday, *Chemical Assistant in the Royal Institution.*

THERE is an experiment usually made in illustration of the properties of hydrogen gas, which was first described by Dr. Higgins, in the year 1777,* and in which tones are produced by burning a jet of hydrogen within a glass jar or tube. These tones vary with the diameter, the thickness, the length, and the substance of the tube or jar; and also with changes in the jet. They have frequently attracted attention, and some attempts to explain their origin have been made.

* Nicholson's Journal, Vol. I. page 130.

After Dr. Higgins, Brugnatelli in Italy, and Mr. Pictet at Geneva, described the experiment, and the effects produced by varying the position and other circumstances of the jet and tube; and M. de la Rive read a paper at Geneva (published in the Journal de Physique LV. 165.) in which he accounted for the phenomenon by the alternate expansion and contraction of aqueous vapour. That they are not owing to aqueous vapour, will be evident from some experiments to be described. I have no doubt they are caused by vibrations, similar to those described by M. de la Rive; but the vibrations are produced in a different manner, and may result from the action of any flame.

I was induced to make a few experiments on this subject, in consequence of the request of Mr. J. Stodart, that it should be introduced at one of the evening meetings of the Members and Friends of the Royal Institution; and was soon satisfied that no correct explanation had been given. That the sounds were not owing to any action of aqueous vapour, was shewn by heating the whole tube above 212°; and still more evidently by an experiment, in which I succeeded in producing them from a jet of *carbonic oxide*. That they do not originate in vibrations of the tube, caused by the current of air passing through it, was shewn by using cracked glass tubes, tubes wrapped up in a cloth, and, I have obtained very fine sounds by using a tube formed at the moment by rolling up half a sheet of cartridge paper, and keeping it in form by grasping it in the hand. The sounds have been accounted for, as well as their supposed peculiarity of production by hydrogen, by the supposition of a rapid current of air through the tube; but that this is not essential, is shewn by using tubes closed at one end, and bell glasses, as described by Mr. Higgins, in his first experiment.

I was surprised to find, on my first trials with other gases, that I could produce those sounds from them which had been supposed to be generated exclusively by hydrogen; and this, with the insufficiency of the explanations that had yet been given, induced me to search after the cause of an effect, which appeared to be produced generally by all flame.

In examining attentively the appearance of a flame when introduced into a tube, it will commonly be found, that, on coming within its aperture, a current of air is established through the tube, which compresses the flame into a much smaller space; it is slightly lengthened, but its diameter is considerably diminished: on being introduced a little further, and as the tube becomes warm, this effect is increased, and the flame is gradually compressed a little above its commencement at the orifice of the jet, more than at any other part; a very faint sound begins to be heard, and as it increases, vibrations may be perceived in the flame, which are most evident in the upper part, but frequently also perceptible in the lower and smaller portion; these increase with the sound, which at last becomes very loud, and if the flame be further introduced into the tube, it is generally blown out. Such are the general appearances with hydrogen. If a jet of olefiant, or coal gas, both of which I have ascertained may be used successfully, be substituted; then, in addition to those appearances, it will be perceived, that as the bright flame of the gas enters the tube, its splendour is diminished, and it burns with less light.

By substituting other gases and inflammable vapours for hydrogen, and using other vessels than tubes, I was enabled so to magnify the effects, as to perceive more distinctly what took place in the flame at these times; and soon concluded, that the sound was nothing more than the report of a continued explosion.

Sir H. Davy has explained the nature of flame perfectly; and has shewn that it is always a combination of the elements of explosive atmospheres. In continued flame, as of a jet of gas, the combination takes place successively, and without noise, as the explosive mixture is made. In what is properly called an explosion, the combination takes place at once throughout a considerable quantity of mixture, and sound results from the mechanical forces thus suddenly brought into action; and a roaring flame presents something of the appearance of both. If a strong flame be blown on by the mouth, a pair of bellows, the draught of a chimney, or other

means, the air and the gaseous inflammable matter are made to mix in explosive proportions in considerable quantities at once, and these being fired by the contiguous flame, combine at once throughout their whole extent, and produce sound: the effect is rapidly repeated in various parts of the flame as long as the air is mixed thus forcibly with it, and a repetition of noise is produced, which constitutes the roar.

Now this, I believe, to be exactly analogous to that which takes place in what have been called the singing tubes; but in them the explosions are generally more minute and more rapid. By placing the flame in the tube, a strong current of air is determined up it, which envelopes the flame on every side. The current is stronger in the axis of the tube than in any other part, in consequence of the friction at the sides and the position of the flame in the middle; and just at the entrance of the tube an additional effect of the same kind is produced, by the edge obstructing the air which passes near it; the air is therefore propelled on to the flame, and mingling with the inflammable matter existing there, forms portions of exploding mixtures, which are fired by the contiguous burning parts, and produce sound, in the manner already described, with a roaring flame; only, the impelled current being more uniform, and the detonations taking place more rapidly and regularly, and in smaller quantities, the sound becomes continuous and musical, and is rendered still more so by the effect of the tube in forming an echo.

That the roaring flame gives sound in consequence of explosion, can hardly be doubted; and the progress from a roar to a musical tone, is easily shewn in the following manner: take a lamp with a common cotton wick, and trim it with ether or alcohol; light it, and hold a tube over the flame (that which I have used is a thin tube of glass about an inch in diameter, and near thirty inches long;) in a few seconds after introducing the flame, the draught will be sufficiently strong to blow it out, but if the current be obstructed by applying the fingers round the lamp at the bottom of the tube, combustion will go on, though irregularly; then, by a little management in admit-

ting the air on one side or the other, and in greater or lesser quantity, it may be impelled on to the flame in various degrees, so as to produce a rough roaring sound, or one more continued and uniform, of a higher note, and more musical; and these may be made to pass into each other at pleasure: then, by substituting a stream ef etherial vapour for the wick, which may be easily done from a small flask through a tube, the tones may be brought out more and more clearly, until they exactly resemble those of hydrogen.

A similar experiment may be made with coal gas; light a small Argand burner with a low flame, and bring a glass tube, which is very little larger than the diameter of the flame, down upon it so as nearly to include it: the current of air will be impelled on the external part of the flame, it will remove the limit of combustion a little way up from the burner, that part of the flame will vibrate rapidly, burning with continued explosions, and an irregular tone will be obtained. Remove the burner, and fix on a long slender pipe to the gas tube, so as to afford a candle flame that may be introduced into the tube; light it, and introduce it about five or six inches, and a clear musical tone will be obtained.

During the experiments that were made in consequence of this view of the subject, many appearances occurred which might be added to the above account, to support the opinion that the vibration of the flame, in consequence of rapid successive explosions, is the cause of the sound; but they are neglected, because they are supposed unnecessary.

If the explanation given be true, then the only requisite to the production of these sounds is the successive sudden inflammation of portions of gaseous explosive mixtures. These mixtures are most easily made by propelling a stream of air on to a stream of inflammable gaseous matter; but it is also possible to make them in other ways, and the same phenomenon may be produced in a different manner.

That the tube is not essentially necessary, is shewn by making it swell out into a cylinder of three or four inches diameter, except above and below; or part of it may be extended into a

globe. I took two air jars that were open above, but with contracted apertures; one of these was inverted over an inflamed jet of hydrogen, so as to form a lamp or bell glass about it: there was no effect of sound, because the downward currents from above interfered with the stream of air issuing up from beneath, and made it irregular; but placing the second receiver on the first, applying them edge to edge; so as to preserve the current of air upwards from disturbing forces, the sounds were immediately produced: and, lastly, I succeeded in obtaining the tones by the draught of a common chimney; for, by attaching a large inverted air jar to the end of a funnel pipe that came from the flue, closing the other lower opening into it, and introducing an inflamed jet of hydrogen within the lower contracted orifice of the glass, the sounds were produced.

That the same sounds may be obtained by means different to those above described, though depending on the same cause, is shewn by some experiments made by Sir H. Davy, in his first researches on the miners' safety lamp. Small wire-gauze safety lamps being introduced into air jars filled with explosive atmospheres, the gases burnt on the inside of the cylinder, and produced sounds similar to those obtained from a jet of flame in a tube.

Having thus endeavoured to account for the phenomenon of sounds produced by jets of flame in tubes and other vessels, I shall notice shortly the combustible bodies I have tried.—Carbonic oxide, olefiant gas, light hydrocarbonate, coal gas, sulphuretted hydrogen, and arsenuretted hydrogen were burned at the end of a long narrow brass tube rising up from a tranferring jar placed under pressure in a pneumatic trough. Ether was burned from the end of a tube fixed in a flask containing a small quantity which was heated; but a better method, and one I afterwards adopted, is to pour a little ether into a bladder, and then force common air in; so much ether rises in vapour as to prevent the mixture being detonating, and it may be pressed out, and burnt at the end of a tube. All these were very successful. Alcohol was more difficult to

manage from being less volatile; but it succeeded when raised in vapour from a flask and burnt at a tube. In trials made with a wax taper, no distinct tone could be produced; but when the tube was made very hot, so as to assist the current through it, something like the commencement of a sound was heard at the moment the taper was blown out by the current.

Hydrogen is by far the best substance by which to produce these tones; and its superiority depends upon the low temperature at which it inflames, the intense heat it produces in combustion, and the small quantity of oxygen that a given bulk of it requires. It is in consequence less easily extinguished by the current than other gases, the current formed is more powerful and rapid, and an explosive mixture is sooner made. With gases producing little heat by combustion, and therefore occasioning but a feeble current, the effect is increased by first heating the tube at a fire, and when not heated previously, the tone is perceived to improve as the tube becomes hot from the flame playing in it.

Some variations of the form of the vessel inclosing the flame, and the material used, have been mentioned. Globes from seven to two Inches in diameter, with short necks, give very low tones: bottles, Florence flasks, and phials have always succeeded: air jars from four inches diameter to a very small size, may be used. I constructed some angular tubes of long narrow slips of glass and wood, placing three or four together, so as to form a triangular or square tube, tying them round with packthread, and easily obtained tones from hydrogen by means of them; and it is evident that variations of the channel, the use of which is to form and direct the current of air, may be made without end.

May 11th, 1818.

Art. XI. *On the Aqueduct of Alcantara.* *By* George Rennie, *Jun. Esq.*

In tracing the origin or the progress of this undertaking, it might be deemed necessary to investigate the moral and political institutions of the people with whom it originated; that the advancement of civilization, and its connection with the sciences, should be contrasted with the systems of social order which have successively arisen, and that the principles which conduce to the display of human knowledge (in these branches), should be severally developed; but the subject is at once intricate and irrelevant, and the difficulty of accommodating historical inferences to existing facts, is a sufficient obstacle to the present inquiry.

The annals of the Portuguese nation present throughout a series of strange, and important events. Conquests and commerce, revolutions and religion, characterise the history of a people distinguished for energy and enterprise, which, while it spread the renown of its heroes and its navigators, led the way to that species of infatuation which eventually terminates in moral debasement.

Before the reign of John V. King of Portugal, the public mind, hitherto absorbed in its foreign relations, seemed to have lost every taste for the cultivation of those arts which constitute the embellishment of a state; and it is only from the exertions of that prince, that the revival of learning in Portugal can be dated. The wisdom of his legislation, and the magnificence of his public works, entitle John V. to the appellation of Great; though it is to be regretted it was ever tainted with the association of bigotry. It was in this æra that the Aqueduct of Alcantara arose.

The situation of Lisbon, on an assemblage of hard and calcareous hills, precludes the advantage possessed by other capitals, of a ready supply of water. It occasionally exhibits itself in sinking wells, but of an indifferent quality, and unfit for domestic purposes; hence it is principally used in irrigation.

It is then lifted from a well of about twenty feet deep, and ten feet diameter, by means of a *nora*, which consists of a chain of revolving earthen buckets of about one English gallon each. There are often two series of these resting on vertical wheels, whilst a horizontal wheel and spindle (working between them), is turned by a lever of about ten feet six inches in length, which connects an ox, or a mule, to a yoke. One of these animals, raises about fifty buckets per minute, which discharge themselves in rotation into an inclined trough above, whence it is conveyed by narrow cuts to the different parts of the quinta; a bell is usually attached to the lever to indicate that the animal is going; and thus with this rude machine he works throughout the day.

In the year 1511, the first idea of supplying the capital with water was suggested by Emanuel the Great, King of Portugal, It was proposed by his architect, Francisco de Olhando, that some neighbouring springs should be conducted to a magnificent fountain, to be erected in the Praça do Rocio, in which a column surmounted by an allegorical figure of the city of Lisbon, was guarded at the base by four elephants spouting water into a marble basin; but the scheme was unaccountably abandoned. The next attempt was made by the Infante Dom Luis, but with as little success.

According to Luis Marinho, a sum of 600,000 crusadoes was raised by public subscription to defray the expense; but the money was foolishly lavished in honour of the entry of Philip III. of Spain, into Lisbon. Five successive sovereigns passed over, until the year 1713, when the foundation stone of the present aqueduct was laid under the auspices of John V. by a Neapolitan, named Canavarro, who died during the progress of the work. He was then succeeded by Brigadier Mansel de Maya, who finished it August 6th, 1732; others say 1738; since which it has remained, notwithstanding the dreadful Earthquake of 1755, an unshaken monument of stability and grandeur, to the contemplation of present and future ages.

The writers who have hitherto given a description of this undertaking, have principally confined themselves to private

memorials; for, with the exception of Murphy, and several engravings, the public are in possession of few details, or exact measurements.

In 1749, a perspective representation was published in London, by Bowles.

In 1763, Mr. Andrew Frazer made some private notes of it.

In 1768, a sketch of the grand arch was presented by Col. Elsden to Sir Francis Gosling, and on the back of it part of another one taken by Mr. Robert Gosling; and about the same time a very imperfect representation by Mr. J. Hunter. Col. Elsden's, which is the best hitherto made, is now in possession of W. Mylne, Esq., who had the goodness to lend it.

In 1769, an original of this plan was presented to the celebrated Marquis de Pombal, and is now preserved in the family house at Oeras: the following description is annexed to it.

Esta nobre e suberba obra tem a seu principio no fim da Ribeira de Carengue, e vay em partes por baixo da terra, e em outras partes, com arcos magnificos, pela distancia de tres leguas e meya, ou 9000 toises, tendo 127 arcos.

Este risco he aquelle pequeo porcaõ de este grande obra que a travessa a ribeira de Alcantara saõ 35 arcos.

O arco grande tem 315 palmos* de altura, 150 de largo.

Estes arcos tem de distancia 400 toises.

Por Luis L'Huylier de Rozierres, Adjutant Ingénieur Volontaire sous la direction de Mons. le Lieut.-Col. Guilleaume Elsden, August 12th 1770.

Besides the information which Mr. Bell, of Lisbon, kindly afforded from the numerous documents and actual measurements possessed and made by him, Murphy, as a public writer, is also referred to, although his account is far from being satisfactory. In the Voyage fait aux Côtes de Portugal, par M

* The Portuguese varra of 5 palmos de Craveira, or 40 inches, is exactly=43½ English inches, or 8,64 English inches to the palmo, consequently the great arch being 315 palmos= 229 ft. 8 in.; Span, 150 palmos=108 ft.

Bory, in the Histoire de l'Académie Royale des Sciences, for the year 1772, page 144, is a short account, and an engraving of the principal arch.

In 1792, an elevation, and short description, was published in London, by B. Wells, which is now scarce.

A perspective engraving by Leveque, is a good representation; and it has been occasionally and vaguely noticed by travellers, and professional writers; but with the exception of the above mentioned elevation, the public are in possession of no dimensions.

The following description therefore may be perhaps acceptable, from being the result of much personal attention and time devoted to the subject, which without any previous acquaintance with, or reference to the documents here presented, but solely dictated by curiosity, is now for the first time contrasted with the labours of others.

The Aqueduct of Alcantara, from its source at Bellas to its termination at Lisbon, is 56,380 feet long. The springs which feed it come from Ribeira de Carenque, Cannessas, and other adjacent places, whence they are conducted, and united to the aqueduct in a small semicircular channel: the water then commences its course at a gentle velocity, augmenting in quantity, by the union of several tributary springs, until it arrives at the valley of Alcantara, where it crosses in a stream of 13 inches wide, by 7 inches deep, and thus passes on to Lisbon.

Throughout the whole course of this stupendous work, the utmost skill is visible in preserving the inclination, and in the masonry; but the circuitous windings, subterraneous passages, and numerous arches, offer but indifferent specimens of hydraulic art. Of the former there are 65 angles, and of the latter 127 arches. Light, and air, are admitted into the vaulting enclosing the channels by windows and towers placed at certain intervals, which are furnished with close iron gratings, to prevent the admission of noxious ingredients.

Plate IV. represents that part of the aqueduct which crosses the valley of Alcantara.

Plate V. a plan and section above the middle arch.

The steepest or eastern bank is the Lisbon side, and the gently rising or western bank the Bellas side; the spectator will then face the south. A statue of John V. is represented in Roman costume on a pedestal on the eastern end, where the foot path commences, from which to the arch No. 1, is 570 feet 7 inches solid wall.

The following table of dimensions shews the relative value of each authority.

	No	Col. Elsden Arch	Col. Elsden Pier	B. Wells Arch	G. Rennie Arch	G. Rennie Pier
	1	28	20	28 7	28 7	18 6
	2	29	17 6	29	28 7	21 4
	3	35 6	21 6	43	35 7	24 11
Gothic Arch begins.	4	65 6	26 6	43	42 8	24 11
	5	65 6	27	56	57 4	24
	6	65 6	25 3	60	64 6	25 8
	7	72 6	28 6	70	Not measured.	28

Great Arch.

		Arch	Height
8	Bowles	150	249
	Frazer	110	215
	Elsden	108 6	224 10
	Gosling	90	216
	Rozierres	108	226 8
	Bell	104 9	212
	Murphy	107 8	230 10
	Bory	108	216
	Wells	108 5	
	Rennie	108 2	220

No	Col. Elsden Arch	Col. Elsden Pier	B. Wells Arch	G. Rennie Arch	G. Rennie Pier	
9	70	26	72	72 2	26	
10	65 6	26	65 10	65 6	26	
11	65 6	26	65 10	65 5	25	
12	65 6		65 10	65 6		
13	59	22	54 8	57 7	25	
14	59	22 3	54 8	57 5	25	
15	50 6	22 3	54 7	50 6	24 3	
16	43	21 6	44 4	34	21 8	
17	41 6	15 9 15 9 (Two sides of angle.)	44 4	33 8	14 4 14 4	Two sides of angle.

End of Gothic arches.

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* Gosling must have only taken the distance between the projecting abutments, which in August gave 94 ft. 7 in.

Here commence the circular arches:

No.	Col. Elsden Arch	Col. Elsden Pier	B. Wells Arch	G. Rennie Arch	G. Rennie Pier
18	42 9	18 6	44 4	43 7	21 8
19	42 9	18 6	44 4	43 10	21 4
20	39	18 6	36 5	42 10	21 4
21	30	17 6	36 5	35 11	17 10
22	30	17	36 6	35 10	17 9
23	29 6	16 6	36 5	35 10	17
24	21	14 6	29 2	28 8	14 3
25	21	14 6	29 2	28 7	14 3
26	21	14 6	29 2	28 8	14 3
27	21	14 6	29 2	28 7	14 3
28	20 6	14 6	29 2	28 7	14 3
29	20 6	14 6	29 2	28 8	14 4
30	20 6	14 6	21 10	21 5	14 4
31	20 6	14 6	21 10	21 5	14 2
32	20 6	14 6	21 10	21 7	14 3
33	20 6	14 6	21 10	21 6	14 3
34	20 6	14 6	21 10	21 5	14 3
35	20 6		21 10	21 6	

The superstructure is divided into two kants, or branches; of which the following are the lengths.

	Mr. Bell	French authority unknown	G. Rennie
Great branch	1936 0	1954 7 4	1931 0
Small ditto	1125 6	1136 7	1150 6
Total length	3061 6	3091 2 4	3081 6

	Ft.	In.
The breadth of the work above the buttresses is	23	3
By some authorities - - -	23	7

The plan and section being drawn to the scale, explains all the other dimensions.

The middle arch, as well as all the other arches are extremely well executed; and in standing at the western angle, the eye ranges over the piers, without the slightest variation of any of them from the vertical plane. The joints are close, and the horizontal lines well preserved. The voussoirs of the arches appear of equal length, and their extrados are adapted to the courses of 16 inches deep each. Those of the middle arch appear about 8 feet in length, and fifteen of them constitute the depth of the work; but the four ranks of projecting stones,

which probably carried the centreing, hurt the uniformity. The only perceptible sinking occasioned by the earthquake is in the north parapet and in one of the towers. A stream, or rather winter-torrent runs through the channel under the great arch, and empties itself into the Tagus about two miles distant.' The width of the section at top is 30 feet 1 inch, and at bottom 25 feet 10 inches.

The valley of Alcantara is fertile but not picturesque; Hoffmanzeg discovered several plants peculiar to the tropical regions; and the botanist L'Ecluse spoke enthusiastically of its productions; but with the exception of the orange plantations near the stream, the features are rough and uninteresting. The radiation of heat concentrated in the valley is too powerful for vegetation, and were it not tempered by the prevailing north winds of the summer season, the heat would be insupportable.

According to Link, the basalt commences about half a league behind Belem, whence it continues up the valley of Alcantara to Beinfica and the Cabeça de Montachique, and then returns back, forming as it were an annular bed, or mass of basalt, covered occasionally with a cream coloured calcareous stone, of a fine granular texture, and slightly translucent; it occasionally exhibits opaque nodules of considerable hardness, which render it unfit for delicate sculpture, although the Portuguese masons work it very skilfully. It is asserted that basalt only shows itself (in Portugal) here and at Cape St. Vincent's, at both of which places the effects of the earthquake in 1755 were most severe.

The water of the aqueduct has a fine clear appearance; but it holds a large portion of carbonate of lime in solution, which gradually deposits in concentric rings in the interior of the pipes until their area becomes reduced to a small hole of the size of a pin's head. The pipes being of lead are then ripped open and folded back, leaving a nucleus as hard as the original stone.* The inspector says each ring denotes one year. In-

* A specimen taken from the interior of a pipe 7 inches bore

deed the velocity of the water is so trifling, that the evil cannot be remedied in the present case.—Vandelli dedicated a long memoir on the subject, in the Memorias Economicas of the Academy of Sciences at Lisbon, entitled Memoria sobre as Aguas Livres, por Domingos Vandelli.

He blames the directors for not using the great reservoir constructed for that purpose; for not rejecting improper springs; for having no analysis of each spring. He advises that the pipes should be of metal; that a description and topographical chart should be made of them; that proper valves should be furnished to each chafariz, or fountain, to prevent the continual run, and waste of water; that a proper distinction should be observed in portioning out the different supplies for different purposes, and that tanks or reservoirs should be constructed to allow of a purification.

In 1791 he gives the following analysis of the united springs in the Aqueduct, and of a single spring from Carengue.

A canada † contains	Magnesia	1 Grain.
———	Selenite -	3
———	Common salt -	2
———	Earthy muriates	1
		7

Gas not noticed.

De Carengue.

A canada	Magnesia - - -	6
———	Selenite - -	2
———	Common salt - -	4
———	Earthy muriates -	2
		14

He says, that "the water, percolating columnar basalt, must acquire some deteriorating matter." And concludes by proposing certain remedies to his objections.

was sent to Mr. Brande for his inspection, who pronounced it to be nearly a pure carbonate—Its specific gravity is 2.377. Its crystals are shining and lamellated.

† A canada is 266.54 English gallons.

With regard to the reservoir, it is a large square building to which the aqueduct joins, by several semicircular arches of about 60 feet span, and into which the water from the channel was to flow in a cascade, and thus fill it up to 25 feet in depth. But it was afterwards judged to be unsafe, from the internal pressure being likely to force the walls, and do mischief in the city, which, from being completely commanded by the reservoir might be incalculable

The internal dimensions of the cistern are 92 feet 7 inches by 79 feet 10 inches, and 25 feet deep. Four stone piars of eight feet square, rise from the bottom of the cistern, to support the brick vaulting above, which is still unfinished. The floor is finely laid, and the sluices well executed. The view from the summit of this building is superb, presenting every feature of a fine landscape.

On the external face of the south side of it, a marble tablet contains the following inscription.

Joannes V
Lusitanorum Rex Magnificus
Liberalis
Civitate Profitens
Excipiendis Aquas Populo
Manantibus
Hanc Molem Struendam
Curavit
Orbis Miraculum
Tanti Nominis
Aeternitatis

And on a Triumphal Arch adjacent, the following:—

Joannes V
Lusitanorum Rex
Justus Pius Aug Felix P. P.
Lusitania in Pace Stabilita
Viribus Gloria opibus Firmata
Profligatis Difficultatibus
Imo Prope Victa Natura

Perennes Aquas in Urbem invexit
Et
Brevi undivigenti Annorum Spatio
Minimo Publico
Immensum opus confecit
Gratitudinis Ergo
Optimo Principi
Et
Publicæ utilitatis Auctori
Hoc Monumentum Pos. S. P. Q.—
Anno MDCCXXXVIII

The water channels r r (Plate V.) are hollowed out of one stone, and cemented at every joint, with a composition of finely powdered brick, freestone, and limestone, mixed up with oil and turpentine.

The channels are 13 inches wide by 11 inches deep, but seldom contain more or less than 7 inches depth of water in summer or winter.

The difference of level between the commencement and termination of the aqueduct was not ascertained, but the velocity of the current was 90 feet per minute, and the consequent expenditure 279 English gallons in that period.

There are sixteen fountains, each of which is said to yield 1½ almudas* in 75″, or 2774 quarts, or 693,5 English gallons, per minute, or 11096 gallons for all the fountains, from which the water must be carried by the galegos, or porters,

Eighteen men are constantly employed, whose wages and incidental expenses amount to 700 milrees per month, or about 3154*l.* annually.

The annual revenue is ninety millions of reis,* or 25,125*l.* leaving a disposable sum of 21,971*l.* These calculations being merely collected from verbal statements, cannot be relied on.

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* The almuda is about 23 quarts.

† Arising from a tax of one rei on every pound of meat sold in the market.

The velocity of the stream is the only criterion of authority we have; inaccuracies and mistatements may have unavoidably occurred; but whatever was subjected to measurement, is given with confidence.

Thus much for this undertaking. Its merits, its principles, and its utility, may be called in question. In point of magnitude it has few rivals; and the reflecting mind, while it censures its defects, allows its Author to say with the poet,

Exegi monumentum ære perennius
Regalique situ Pyramidum altius;
Quod non imber edax, non Aquilo impotens
Possit diruere, aut innumerabilis
Annorum series, et fuga temporum.
Non omnis moriar, multaque pars mei
Vitabit Libitinam.

Art. XII. *Report of* Mr. Brande's *Lectures on Mineralogical Chemistry, delivered in the Theatre of the Royal Institution, in the Spring of* 1817.

[Continued from page 73.]

Iron is a metal so generally diffused throughout nature, that there are comparatively few fossils which can be said to be perfectly free from it. It is confined to no particular formation, or series of rocks, but pervades primary, transition, secondary, and alluvial strata. Water often holds one or more of its saline combinations in solution, and thus forms chalybeate springs; and vegetable and animal bodies afford more or less of it when submitted to the processes of analysis.

The proper ores of iron are also very numerous, and it exists in so many combinations with other bodies, that it often becomes very difficult to say what should be regarded as the characteristic ingredient.

These considerations alone, render the subject now before me of much interest to the mineralogical and analytic chemist; but when we reflect upon the circumstances connected with it, the

history of iron assumes an importance which might justly entitle it to be distinguished as the king of the metals. It is the principal metallic ingredient in those lapideous masses, which in different countries have fallen upon our globe, and which have been termed meteoric stones. Though we really know nothing of the source or origin of these bodies, it has been ascertained upon the most satisfactory and indisputable evidence that they are not of terrestrial formation, and consequently, since men began to think and reason correctly, their visits to our planet have awakened much speculation, and some experimental research.

In the first place, it deserves to be remarked, that we have very distinct evidence of the falling of stony bodies from the atmosphere in various countries, and at very remote periods. For, to say nothing of the fabulous trash which encumbers the annals of ancient Rome, or the extended catalogue of wonders flowing from the lively imagination of Oriental writers, such events are recorded in holy writ, and have been set down by the most accredited of the early historians; and although philosophic scepticism long contended against the admission of the fact, it has in modern times received such unanswerable proofs, as to be allowed by all who have candidly considered the evidence, and is only rejected by the really ignorant, or by those who, for the sake of singularity, affect disbelief.

The first tolerably accurate narration of the fall of a meteoric stone, relates to that of Ensisheim, near Basle, upon the Rhine. The account which is deposited in the church was thus: A D. 1492, Wednesday, 7 November, there was a loud clap of thunder, and a child saw a stone fall from heaven; it struck into a field of wheat, and did no harm, but made a hole there. The noise it made was heard at Lucerne, Villing, and other places; on the Monday King Maximilian ordered the stone to be brought to the castle, and after having conversed about it with the noblemen, said the people of Ensisheim should hang it up in their church, and his Royal Excellency strictly forbade anybody to take any thing from it. *His Excellency however, took two pieces himself, and sent another to Duke Sigismund of Austria.* This stone weighed 255 lbs.

In 1627, 27th November, the celebrated Gassendi saw a

burning stone fall on Mount Vaisir, in Provence; he found it to weigh 59 lbs.

In 1672, a stone fell near Verona, weighing 300 lbs. And Lucas, when at Larissa, 1706, describes the falling of a stone, with a loud hissing noise, and smelling of sulphur.

In September, 1753, de Lalande witnessed this extraordinary phenomenon, near Pont de Vesli. In 1768, no less than three stones fell in different parts of France. In 1790, there was a shower of stones near Agen, witnessed by M. Darcet, and several other respectable persons. And on the 18th of December, 1795, a stone fell near Major Topham's house in Yorkshire; it was seen by a ploughman and two other persons, who immediately dug it out of the hole it had buried itself in; it weighed 56 lbs.

We have various other and equally satisfactory accounts of the same kind. All concur in describing a luminous meteor moving through the air in a more or less oblique direction, attended by a hissing noise, and the fall of stony or semimetallic masses, in a state of ignition. We have however evidence of another kind, amply proving the peculiarities of these bodies. It is, that although they have fallen in very different countries, and at distant periods, when submitted to chemical analysis they all agree in component parts; the metallic particles being composed of nickel and iron; the earthy of silex and magnesia.

Large masses of native iron have been found in different parts of the world, of the history and origin of which nothing very accurate is known. Such are the great block of iron at Elbogen in Bohemia; the large mass discovered by Pallas, weighing 1600 lbs. near Krasnojark in Siberia; that found by Goldberry, in the great desert of Zahra, in Africa; probably also that mentioned by Mr. Barrow, on the banks of the great fish river in Southern Africa; and those noticed by Bruce, Bougainville, Humboldt, and others in America, of enormous magnitude, exceeding 30 tons in weight. That these should be of the same source as the other meteoric stones, seems at first to startle belief; but when they are submitted to analysis, and the iron they contain found alloyed by nickel, it no longer seems credu-

lous to regard them as of meteoric origin. We find nothing of the kind in the earth.

To account for these uncommon visitations of metallic and lapideous bodies, a variety of hypotheses have been suggested. Are they merely earthly matter fused by lightning? Are they the offspring of any terrestrial volcano? These were once favourite notions; but we know of no instance in which similar bodies have in that way been produced, nor do the lavas of known volcanos in the least resemble these bodies, to say nothing of the inexplicable projectile force that would here be wanted. This is merely explaining what is puzzling, by assuming what is impossible; and the persons who have taken up this conjecture, have assumed one impossibility to account for what they conceive to be another, namely, that the stony bodies should come from any other source than our own globe.

The notion that these bodies come from the moon, though it has been laughed at as lunacy, is, when impartially considered, neither absurd nor impossible. It is quite true, that the quiet way in which they visit us is against such an origin; it seems, however, that any power which would move a body 6000 feet in a second, that is, about three times the velocity of a cannon ball, would throw it from the sphere of the moon's attraction into that of our earth. The cause of this projective force may be a volcano, and if thus impelled, the body would reach us in about two days, and enter our atmosphere with a velocity of about 25000 feet in a second. Their ignition may be accounted for, either by supposing the heat generated by their motion in our atmosphere sufficient to ignite them; or by considering them as combustibles, ignited by the mere contact of air.

While we are considering the *possibility* of these considerations it may be remembered, that in the great laboratory of the atmosphere, chemical changes may happen, attended by the *production* of iron and other metals; that at all events such a circumstance is within the range of possible occurrences; and that the meteoric bodies which thus salute the earth with stony showers, may be children of the air, created by the union of simpler forms of matter. The singular relationship between iron and nickel, and magnetism, and the uniform influence of meteoric

phenomena upon the magnetic needle, should be taken into the account in these hypotheses.

The existence of masses of native iron has led me to these questions, which, least they should be deemed irrelevant, I will pursue no more.

The ores of iron may be classed under three divisions, of which the first includes chiefly mineralogical curiosities, such as arseniate, chromate, phosphate, and a few other rare combinations.

The second embraces the sulphurets of iron, of great use in affording some of the saline combinations, such especially as *green vitriol* or *copperas*. These ores are known under the name of *Pyrites*. Black or magnetic pyrites contains 63 iron + 37 sulphur. Yellow or common pyrites consists of 46 per cent. iron + 54 sulphur.

This is abundant all over the world. Large crystals have been found in the graves of the Incas of Peru, and seem to have been used as mirrors. Globular masses of it occur in chalk. Some varieties are very liable to decomposition, and consequently often mischievous in a mineralogical cabinet.

The most interesting ores of iron are those in which the metal is united to oxygen. These are the sources of the enormous quantities of this body that are called for in commerce. There are two oxides of iron, which have been termed the black and the red; the one consisting of 100 iron + 30 oxygen, and the other of 100 iron + 45 oxygen. They both occur native; the former principally in primitive, the latter in secondary rocks.

Magnetic iron ore is one of the purest varieties of the protoxide of iron; the fine bar iron of Dannemora is made from it; but it is not the ore used in England, though found in Cornwall, Devonshire, and the Shetland Isles. It not only attracts the magnet, but is itself often polar. It occurs massive and variously crystallized, its primitive form being the octoedron.

Specular iron ore, or iron glance, is a variety of this oxide; it is very slightly magnetic. The mines of Elba, which have been worked for 3000 years, afford magnificent specimens; it is easily distinguished from magnetic iron by affording a red and not a black streak, when rubbed on paper.

By the processes of fusion, puddling, and rolling, described in my last Lecture, iron is separated from the combination in which it exists in the ore, and is obtained in the various states of cast or pig iron, and of forged, bar, or malleable iron. The characters of cast iron, by which it is most evidently different from bar iron, are its brittleness, and fusibility; circumstances dependent upon extraneous matters, which by chemical union with the pure metal thus modify its characters. These substances are chiefly carbon, and the metallic bases of some of the earths, forming compounds which have hitherto been but little examined, but which promise to become important. Independent, however, of composition, the mechanical structure of different kinds of iron is extremely various, a subject which has been very ingeniously investigated by Mr. F. Daniell, and of which he has given an account in the Journal of Science and the Arts. Thus, gray cast iron, submitted to dilute muriatic acid, seemed made up of numerous bundles of minute needles. Bar iron, which had undergone the operation of puddling and rolling, presented fibres running parallel to its length; and indeed, if we tear bars of malleable iron asunder, we shall observe their fibrous texture.

Steel is a compound also of iron and carbon, generally made by heating bar iron in contact with charcoal; so far therefore it resembles cast iron; but it does not afford siliceous earth, or manganese on solution. The different kinds of steel contain very different proportions of carbon; and it seems principally to this circumstance, that their different qualities are to be referred. But another cause of variation is referable to what is called tempering, and by this process the hardness of steel is very curiously modified: when a steel instrument is heated and plunged into water it becomes very hard, but likewise very brittle; and as different cutting instruments require very different degrees of hardness, it becomes necessary again to soften them down to a proper point. Files are the hardest steel instruments used, and are heated red hot and plunged into water. If a file be now again heated to a particular degree, it softens, or is tempered, and acquires a varying hardness at different thermometrical points. If the steel in

this state be polished, we observe that its surface undergoes various changes of colour; first it becomes pale yellow; then bright yellow; then reddish brown; then blueish, and light blue, then full blue; and lastly purple and black. The cause of this change in the hardness of the steel is referable to change of texture; and the great alteration it suffers has been rendered curiously evident by Mr. Daniell. A bar of steel was broken in two and heated red; one part suffered to cool spontaneously, the other quenched in water. The former was easily acted upon by muriatic acid, the latter with much greater difficulty. The former had a fibrous and wavy texture; the latter was like worm-eaten wood, compact, and not striated.

In noticing the singular properties exhibited by different kinds of steel and iron, Mr. Brande mentioned the mode of imitating Damascus sword blades, and the manufacture of stub iron.

Tin is a metal, the mineralogical history of which is extremely simple, for there is only one ore, which is the *native oxide*, or *tin stone*. It is found crystallized in octoedra and in four-sided prisms, resulting from their elongation. It often presents curious *macles*, or twin crystals. A ferruginous variety of oxide of tin forms the wood tin ore. Those who are curious in regard to the history of this ore, I must refer to a valuable dissertation upon it by Mr. Phillips, in Vol. II. of the Geol. Trans.

Tin, geologically speaking, is an old metal; its veins are cut by those of copper. Cornwall may be considered as the richest tin district in the world. It traverses granite and slate, accompanied by quartz, &c. Sometimes immense masses of the ore have been raised, and it is curious that particular varieties of crystallisation belong to particular mines. Thus *Penandrae* near Redruth abounds in twin crystals; *Polgarth—Huel Fanny*, and other mines, are renowned for particular crystalline forms. The ores are reduced by simple ignition with charcoal.

Pure tin approaches silver in appearance. Its specific gravity is 7,9. It is malleable and melts at 442° Fahrenheit.

There are two oxides of tin, the gray and the white. The former contains, 100 + 14 oxygen; the latter, 100 + 28. These oxides are soluble in fixed alkalies. Tin is not easily oxidized by air and moisture; hence tin plate, which is an alloy of iron and tin, is much more durable than iron.

The two oxides combine with acids; the salts containing the *protoxide* have a strong attraction for oxygen; and hence precipitate many of the metals in a metallic state, or otherwise rob them of oxygen. Nitromuriate of tin is used by dyers of scarlet.

Art. XIII. *On the Ventilation of Covent Garden Theatre.*

On a former occasion (Vol. IV. p. 383) we adverted to the ingenious and effectual manner in which the ventilation of Covent Garden Theatre has been effected. At the desire of many of our readers, we applied to Mr. Harris for permission to examine the various contrivances, and to inquire into their efficacy, which was most liberally granted; and we are indebted to the Marquis de Chabannes, under whose directions the ventilation has been perfected, for the description and plates annexed.

We have before stated, that the principle of ventilating and regulating the temperature of this large building depends upon the constant admission of fresh air into the lower parts of the theatre, cold or warm, as the season requires, while the heated and foul air is continually carried off by tubes connected with heated cylinders. The gas lights are well contrived, so as to co-operate in this ventilation, and thus, while the house is admirably lighted, the whole of the burned air is conducted away, and none of that closeness and suffocating sensation is perceived which common lamps are apt to produce, and which is more especially occasioned by ill-devised gas illumination.

The following description of the plates will sufficiently explain the most important parts of the apparatus by which the temperature of the building is regulated, and by which a

constant renovation of the air is effected. Those who are inquisitive, will find thermometers in different parts of the theatre, which amply demonstrate the efficacy of the plan. In winter they are kept up at 60°, and in the warm weather seldom exceed the external temperature more than a few degrees, an advantage of which no other theatre can boast.

Plate VI. represents a ground plan and section of Covent Garden Theatre.

Description of the Ground Plan.

a. The stage.

b. The audience.

c. A stove at the Bow-street entrance. It was necessary to give great power to this furnace, that from the warm air mixing with the external air admitted by the swing doors, the temperature of the grand staircase might be always maintained from 55 to 60 degrees, whatever might be the cold on the outside of the building. On the power of this furnace depends, in a great measure, the temperature of the corridores.

d. Shakspeare's room. This being a waiting room not only for the half-price visitors, but also for the public in going out while waiting for their carriages, it was essential to place two stoves, as at *f*, which producing three times more heat than a common stove, might maintain the corridores at 60, independent of the furnace, which must cease to be lighted when the thermometer is above 50 out of doors.

e. Piazza entrance. A furnace is placed below this entrance, and the warm air is thrown out at each side of the flight of steps, by which means the air, which enters the body of the house through the doors above, is always at from 55 to 60 degrees.

f. Stoves in the lower saloon, and in the corridore of the dress circle on the King's side, as well as in the saloon and corridores above, not seen in the plate, which diffusing a large quantity of warm air, are of great benefit in pre-

venting any current of cold air between the boxes and corridores. They are more particularly required the days in which the furnace below is not lighted, in order to maintain a proper temperature in the corridores, by which, instead of feeling chilly in passing through them, one is, in every part, as comfortable as if in a moderate sized apartment.

g. A furnace is placed underneath to warm this staircase, which leads to the private boxes on this side of the house, and one issue of hot air is also thrown into the private staircase leading to his Royal Highness the Prince Regent's box. The private box staircase on the other side being on a much smaller scale, a stove has merely been placed below to temper the air from the exterior.

h. A very powerful furnace is erected under the pit entrance, and the warm air is thrown up in three places, which are not marked in the plate, being under the boxes. The most powerful heat is in the centre of the corridore round the pit, and at this entrance outside the swing doors which are entirely open to the external air, but for the powerful heat issuing immediately between the 1st and 2nd swing doors, the rush of air would be very dangerous. Thus the rush, which is admitted into the pit and body of the house by the centre 2nd swing door, is always at a temperate degree, and does away with the draught which formerly used to be complained of by persons in the front of the dress circle every time they were opened, and which would now be doubly injurious from the very powerful ventilation. The other heats are at the side doors into the pit, and have the same effect there, as well as preventing the cold from annoying persons seated in the front benches of the pit, by rushing to their legs and feet. It is further proper that the air in this corridore should be at 60 degrees, as it is from hence principally that air is supplied to the interior of the boxes—blaze openings communicate with the passage between the basket and dress circle immediately above, as at *i*, and

would be dangerous and unpleasant if the temperature of the corridore, from whence it is taken, was not kept at an equal degree to those above.

i. Openings to admit fresh air in the corridore between the basket and dress circle.

k. Two double wooden trunks, to supply fresh air to the first and second tier.

l. Forty-four steam cylinders placed round the mazarine floor underneath the stage, and supplied by a steam boiler.

m. Corridores running between the dressing rooms and stage, and warmed by the furnaces at each staircase entrance *n*.

n. Two staircases leading to the stage and all the upper dressing rooms. Two powerful furnaces are erected underneath, and the warm air discharged immediately in the centre of each, preventing any cold air rushing to the stage, and warming all the communications to it.

Description of the Section of Covent Garden Theatre.

a. The stage.

b. The audience.

c. Ventilating furnace erected in the lower gallery, of which a minute description is given in plate VII. and which draws the vitiated air from the basket and different tiers of boxes by conductors *d*.

d. Conductors for impure air from the different boxes to the recipient of the ventilating furnace.

e. Third tube. A tube surrounding that which carries off the smoke and air from the furnace, and by the heat of the inner tube causing a rarefaction, which draws off part of the air from the back of each gallery, and discharges it through the cowl.

f. Ventilation by heat from the chandelier.

g. Ventilation over the stage to carry off any smell from the lamps, and all smoke made on the stage.

h. Tube in which the power to effect the ventilation is placed.

i. Machines for lowering drop scenes.

k. Steam cylinders under the stage—each traversed by thirty pipes of air of two inches diameter each, and consequently spreading throughout an immense quantity of warm air.

l. Steam boiler

m. Back of the stage.

n. Painting room.

o. Pit.

p. Dress circle.

q. 1st circle.

r. 2nd circle.

s. Upper boxes and slips.

t. Tubes communicating from the ventilators in the ceiling to the apparatus over the chandelier.

u. Four sheet-iron boxes, in which the heat of the gas causes a rarefaction, which draws the air from the ventilators in the ceiling.

w. Fresh air at a proper temperature admitted from the pit corridore between the basket and dress circle.

x. Fresh air at a proper temperature admitted by trunks on each side between the ceilings under the 1st and 2nd circles, and diffusing this renewal of air through the various openings under the feet for the purpose.

y. Lower saloon.

z. Upper saloon.

DESCRIPTION OF PLATE VII.

Patent Ventilating Furnace, erected in the Lower Gallery of Covent Garden Theatre.

Fig. 1 *and* 2. *Side and Front Section of Furnace and Fire-place.*

a. Fire-place.

b. Pyramid for supplying coal.

c. Ash pit.

d. Flame and smoke acting on the circumference of the air-pipe.

e. Air pipes in immediate contact with the fire.

f. Flue for smoke to pass off.

g. Tubes communicating with the different tiers of boxes,

and through which the impure air is drawn off by the power of the furnace.

h. Air recipient under the furnaces, into which the conductors from the boxes lead, and communicating with the pipes of the furnace.

l. Flue in which the air from the boxes passes off, and is aided in its ascent by the heat in the smoke flue *f* which envelopes it.

k. Soot doors at the side for clearing out the furnace.

m. The outer tube commencing above the galleries, and carrying off part of the impure air from thence by the rarefaction caused by the heat of the smoke flue *f.*

l. Large iron cowl, moveable with the wind, in which the three tubes unite to carry off the air and smoke.

Fig. 3. *Ground Plan.*

Fig. 4. *n.* One single pipe of proportionate dimension, leading to the recipient of the furnace as proposed for other purposes of ventilation, in lieu of the various conductors.

DESCRIPTION OF PLATE VIII.

Fig. 1. *Section of the Ventilation performed by the heat of the Gas.*

a. Chandelier.

b. Plate iron tube carrying off smoke and heat of gas.

c. Tubes of plate iron communicating by four wooden trunks *d.* to the ventilators round the ceiling.—The heat of the gas causing in them the rarefaction which propels the air through the ventilators.

e. Double case in wood, in which a trunk leading from the first gallery as at *f.* to the bottom of the same, draws the air from that part, and through the openings round the line at *g.*

h. Large iron cowl, through which the whole escapes.

Fig. 2. *Plan of the upper part of the Tubes.*

Art. XIV. *On the increasing Populousness of England.*

The inquiry instituted and census taken in 1801 and 1811, presented results extraordinary as unexpected; showing an accelerated progress of increasing population in Great Britain,

at the close of the last century and beginning of the present; which was thought very unlikely to continue with like rapidity in future.

The proportion of births to deaths had been estimated at 11 to 10, about the middle of the past century;* and that estimate has not been deemed materially defective. In the latter part of the century (taking a period of twenty years) the proportion of registered baptisms to burials in all England and Wales, was found to be 13 to 10; and, on an average of the last five years of it, 137 to 100.† In the first decade of the present age, the proportion exhibited by the returns of parish-abstracts was 148 to 100; and for the last five years of this decennial period, 151 to 100.‡

As the registers of baptisms are known to be more defective than those of funerals; among other reasons, because many dissenters from the established church bury their dead in the parish cemetery, who have not their children baptised according to the rites of the Church; and because private baptisms are excluded from some of the registers,§ and the interment of still-born and unbaptised children is in others included;‖ it followed, that the excess of births above deaths, was still

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* *Dr. Short. New Obs.* 22 and 24.

† In 20 years (1780—1800) 5,014,899 baptisms, and 3,840,455 burials; annual average, 250,745 to 192,023, or 131 : 100.

In 5 last years (1796—1800) average 255,426 to 186,000, or 137 : 100.

‡ In 10 years (1801—1810) 2,878,906 bapt. 1,950,189 bur. or 148 : 100.

In 5 last years (1806—1810) average 297,000 to 196,000, or 151 : 100.

§ *Pop. Abs. Prel. Obs.* 22.

‖ In the bills of mortality for London, abortive and still-born children are included in the burials, to the number of about 600 annually; *Price, Rev. Paym.* In 10 years (1801—1810) 5437; *Milne, Ann.* In the 5 last years (1813—1817), 3551; or, on an average, 710; *Bills Mort.* The whole number of still-born must be much greater; being in proportion of 5 to 100 born alive; *Dr. Clark.* The unbaptised are not fewer; for more die in the first fortnight, than are still-born; *ib.* but not all unchristened.

greater than the abstracts of parish-registers exhibited. Admitting a requisite but conjectural correction upon this ground, the proportion of births to deaths on a medium of the first ten years of the present century, has been taken at 16 to 10;* a proportion considered to be quite extraordinary for a rich and well-peopled territory; showing a rate of increase, which, as remarked concerning it, cannot be permanent; and which it would be unreasonable to expect should endure for any long continuance.†

There seems reason however to believe, that the accelerated progress of increase, exhibited by the growing ratio of excess of births above deaths to the whole population, has yet received no check; and that the augmentation of the people is proceeding with a rapidity as great in the second as in the first decade of the century. As this is a point of much moment in connection with many important considerations, the grounds of the opinion now stated will be given; and with as much brevity as the nature of the subject allows.

The Bills of Mortality of London, annually published, exhibit in the past century an excess of burials above baptisms progressively diminishing, until nearly equalized in the latter part of it: the average of the last five years showing the proportion of 98 baptisms to 100 funerals.‡ From the beginning of the present century, the registered baptisms have exceded the burials; the ratio for the first five years being 108 to 100,§ and for ten nearly the same; and the excess has increased in the present decade, the ratio being for the elapsed portion of it, 115 to 100, and for the last three years, 119 to 100.‖

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* Add one sixth to the registered baptisms: and one-twelfth to the registered burials; *Malthus*, *Pop.* ii.

† Malthus.

‡ In five yrs. 1781—1795, Bap. 86316 Bu. 94403 *Av.* 17263 : 18881
Five yrs. 1796—1800, Bap. 93544 Bu. 95659 *Av.* 18709 : 19132

§ In five yrs. 1801—1805, Bap. 100553 Bu. 92856 *Av.* 20111 : 18571
Ten yrs. 1801—1810, Bap. 199797 Bu. 185736

‖ In 7 yrs. 1811—1817, Bap. 152871 Bu. 133287 *Av.* 21839 : 19041
Three yrs. 1815—1817, Bap. 71124 Bu. 59844 *Av.* 23708 : 19921

The Bills of Mortality are not supposed to be quite accurate. It appears from the parish abstracts returned under the population Acts, that in the last twenty years of the past century, the proportion of baptisms to burials was 92 to 100; but, according to the bills, 94 to 100;* and in the first ten years of the present century, 111 to 100; but according to the bills, 106 to 100.† Presuming, that the bills of mortality will not prove to be now more inaccurate, compared with the abstracts to be returned for a future census than heretofore, there appears to be sufficient evidence, that the excess of births above the deaths within the metropolis is in progress of increase. The town then is no longer a drain upon the country for maintaining the number of its inhabitants, which it upholds and even augments.

Marylebone, which is not included within the bills of mortality, is the most populous parish in Great Britain. The number of its inhabitants, which was 63982, according to the enumeration in 1801, and 75624 according to that of 1811, is almost a twelfth part of the population of the metropolis, and 125th of that of England. It equals, or nearly does so, the aggregate of other parishes contiguous to London, and comprising a portion of the suburbs though not comprehended in the bills of mortality.‡

The registered baptisms in this parish nearly equalled the burials in the ten years from 1781 to 1790; and exceeded them in the next ten, 1791 to 1800; as also in the ten following, 1801 to 1810; the proportion being severally, 96 to 100; 110

* Abstracts of Par. Reg. 1781—1800, Bap. 394309 Bu. 422404
Bills of Mortality - - - Bap. 366191 Bu. 389491

† Abstracts of Par. Reg. 1801—1810, Bap. 210454 Bu. 188910
Bills of Mortality - - - Bap. 199797 Bu. 185655

‡ Pancras, Paddington, Kensington, and Chelsea, contained 53022 inhabitants in 1801, and 80080 in 1811. To the five out parishes mentioned, Camberwell should be added; it contained 7059 persons, in 1801, and 11309 in 1811.

to 100; and 108 to 100.* The excess of registered births above deaths is become yet greater, being for the seven years which have since elapsed, 138 to 100; and for the three last, 157 to 100.†

In the parish of Marylebone, the burials of persons denominated foreigners amount to rather more than 165 annually; and if these were excluded, the excess of births above deaths would appear to be yet greater.

One of the most populous parishes beyond the precincts of the metropolis is Hampstead. Being a resort of the sick on account of the reputed salubrity of the spot, many sojourners die and are interred there; and the funerals, according to the abstracts returned for the census, continued to exceed the baptisms to the latest period of those returns (1810.) The population of the place was 4343 in 1801, and 5483 in 1811; but the funerals in the intermediate ten years were 1377, and baptisms 1124. An accession of inhabitants replaced the deficiency and augmented the number in no less a ratio than as 5 to 4.

In the last five years, the baptisms in this parish have been 646, and burials 642; or in the proportion of 101 to 100 nearly; Instead of the former ratio 82 to 100, on the medium of ten years.‡

As an instance of a rural parish in the vicinity of the metropolis, more than eight and less than ten miles distant from it, the parish of Edgeware has been taken, and upon no other ground of selection besides the accidental circumstance of facility in consulting its register.

The proportion of births to deaths has in this parish increased from the ratio of 123 : 100, which the average of ten years

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* In ten years, 1781—1790, Bapt. 12325 Bur. 12871.
1791—1800, Bapt. 17410 Bur. 14880.
1801—1810, Bapt. 18991 Bur. 17553.
Printed Acc. rec. and disb. of the rates of St. Marylebone.

† In seven years, 1811—1817, Bapt. 57432 Bur. 12660 *Av.* 2490 : 1809
Three years, 1815—1817, Bapt. 7977 Bur. 5089 *Av.* 2659 : 1696

‡ In ten years, 1801—1810, Bap. 1124 Bu. 1377
Five years, 1813—1817, Bap, 646 Bu. 642 *Av.* 129 : 128

exhibited to that of 138 : 100, on the medium of the seven subsequent years; and 147 : 100 in the three last.*

Considering that Marylebone, Hampstead, and Edgeware, are no unfair specimens of three classes of parishes in and near London, it is apparent from these instances, in concurrence with the bills of mortality, that within the metropolis and its immediate vicinity, the population of which is not less than a tenth of that of Great Britain,† the number of inhabitants has continued to increase since the census of 1811; and at an accelerated rate. And, as the number of inhabitants of all Great Britain has hitherto been found to increase faster than that of the metropolis, it seems fairly to be inferred as a probable result to be expected from the next census, that the population of all Great Britain will appear to have been increasing to this time with yet greater rapidity than the results of the former census showed.

To bring this conclusion to the test of a comparison with information collected from remote parts of the kingdom, would require more extensive research, than can well be undertaken by an individual. The registers of a few distant parishes have been consulted; and the results, as might be expected, are various. It is however conceived, that the continued rapid growth of the capital city does assuredly indicate a continuance of quick increase of populousness of the country in general.

H. T. C.

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* In ten years, 1801—1810, Bap. 111 Bu. 9
Seven years, 1811—1817, Bap. 105 Bu. 76 *Av.* 15 : 11
Five years, 1813—1817, Bap. 87 Bu. 59 *Av.* 17 : 12
Population, 412 in 1801; and 543 in 1811.

† The population of London and its neighbourhood, within eight miles around the cathedral of St. Paul's, was 1,220,000, according to the census of 1811; and that of all Great Britain, with the army and navy, was 12,596,803. *Pop. Abs.* Carrying the vicinage to ten miles, the proportion is as stated.

Art. XV. *Observations on the Geology of the West India Islands, from Barbadoes to Santa Cruz, inclusive. By* William Maclure.

[From the Journal of the Academy of Natural Sciences at Philadelphia.]

This range of islands may, in a geological point of view, be divided into two distinct parts, one of which, occupying the eastern side, consists of a stratification of transition of rocks, partially crowned by secondary, and embraces the islands of Barbadoes, Mariegalante, Grandterre in Guadaloupe, Deseada, Antigua, S. Bartholomew, St. Martin, Anguilla and Santa Cruz; the other part, consisting of volcanic formations, with a few partial coverings of secondary, occupies the western side of the range, including the Grenadines, St. Vincent, St. Lucia. Martinico, Dominica, Basseterre in Guadaloupe, Monserrat, Nevis, St. Christopher, St. Eustatia and Saba, where the volcanic formation appears to terminate.

Barbadoes. The northern, southern, and western sections of this island consist of rocks, formed of an aggregate of shells and madrepore rocks, mixed with different kinds of corals, being partly consolidated into a mass by the attrition of the water, having the interstices filled by the particles that have been broken, and washed into them, sometimes even losing the marks of their original formation; and partly porous and full of cavities formed by the washing away of the shells and madrepores, and by the natural shelving of these rocks. This shell limestone is deposited in four or five horizontal strata, rising gradually to the height of eight hundred feet towards the centre of the island, and forming as many *plateaux* as there are strata, resembling at a distant view, the steps of stairs. Thence to the eastward or windward is the district of Scotland, composed of strata of slate alternating with limestone, and an aggregate cemented with lime, in grains of various sizes, and resembling much the different kinds of graywacke slate, dipping to the east, northerly, and running to the north, westerly; having every appearance of

being the transition rock on which the madrepores and corals were formed.

Mariegalante, Grandterre in Guadaloupe, and *Deseada*, are all formed of the madrepore rock, in horizontal strata, resembling the same formation in Barbadoes, the strata being elevated, one above another, and forming a plateau or table of land, at the summit of each, but not rising so high as in Barbadoes. Grandterre in Guadaloupe has this formation, exhibiting more the appearance of undulations, with gentle ascents and declivities, containing some small streams and marshes, which would rather encourage the supposition that it rests on a volcanic basis, and is therefore more liable to have its rocks deranged from their present natural horizontal position.

Antigua. This island not having been visited by the writer, he must take its description from the specimens brought from it, by which it may be concluded, that it is similar, in some of its geological traits, to the island of Barbadoes; having the same formation of madrepore rocks, some of which contain silex in the form of agates, &c; which are valued, as beautiful specimens, by the curious. A part of the island consists of a stratified rock, in the form of a green schist, crossing the island from north to south, in a zone of three or four miles width, affording the inhabitants a useful building stone. The southern side of the island is rugged and mountainous, and is described as being volcanic.

St. Bartholomew. The formation throughout this island is evidently stratified, though in great confusion, (the word stratified is here used in contradistinction to volcanic) the strata running in a direction a little to the west of north, and dipping generally to the eastward, as far as could be ascertained from the disturbed and irregular position of the broken rocks. These rocks are found to consist of three or four species of limestone, two of them containing shells; some aggregates, which are cemented with limestone, and present much the appearance of transition formation; several species of hornblend rock, a little crystalline; amigdaloid, containing small nodules of *calcareous spar* and zeolite, which, when the stone is fresh

broken, are undistinguishable from the mass, and discover their difference only when in a state of decomposition; a soft argillaceous mass, with spots of green, resembling the green earth of Verona; porphyry, with crystals of quartz and feldspar, imbedded in a red argillaceous base, &c. all of them alternating one with another occasionally, and assuming the appearance of a transition formation. But the various aspects which these rocks present, and the different stages of decomposition in which they are found, and in which they differ much from the rocks of a continent, or of northern climates, render it extremely difficult to determine which part may be secondary, and which transition.

St. Martin and *Anguilla* are two small stratified islands, on a line with St. Bartholomew, and consisting of a similar formation.

The island of St. Thomas may also be classed in this range. It is stratified, though in much confusion, and so deranged as to render it difficult to ascertain the general direction, which appears to be from north-west to south-east, dipping easterly. The rocks consist of a variety of aggregates, resembling the transition, some of which when fresh, have the appearance of hornblend rocks, but when beginning to decompose, the aggregate appears, with a few plates of a black crystalline rock like hornblend. I found a yellowish brown quartzy aggregate, resembling a rock, in the transition, at the Lehigh Falls in Pennsylvania.

Santa Cruz. This island, though included in our first division, agrees rather with the direction of the volcanic islands; it appears however, that the volcanic formation ceases at Saba, and that Santa Cruz is composed of madrepore rocks at the west, and on the eastern side, of rocks similar to those of St. Thomas and St. Bartholomew. The west end and the middle of the island are low, and covered with a shell limestone and madrepore rock. The foundation on which this rock reposes is a stratum that retains water, and may be a compact limestone, as the bases of many of the little hills rest on solid limestone. The east end is composed of different kinds of limestone, alternating with amygdaloid, hornblend rock and porphyry, like the rocks of

St. Bartholomew; it is likewise hilly and broken, being stratified in a direction nearly north and south.

All the islands that have been described have a striking similarity both in their structure and the nature of their materials; those that are partly or wholly covered with the horizontal shell limestone, or madrepore rocks, are exactly the same; those partly or wholly formed of stratified rocks, consist of rocks more than half of which are limestone, or have considerable quantities of lime in them, and the remainder of the rocks differ very little, they have nearly the same dip and direction, have a strong characteristic mark of belonging to the transition class; though from their deranged state, and the peculiar mode of their decomposition, they differ a little in their appearance from the transition rocks of Europe, for the limestone is remarkably hard, dry, and brittle, breaking into sharp pieces, which sound like a bell, when struck with a hammer: this may perhaps be the effect of the constant heat of the climate. The different appearance which these rocks assume, when in a state of decomposition, from those of northern latitudes, may in part be attributed to the climate, and partly to the same cause which produced the great confusion in which they are now found, particularly if that cause raised them from the bottom of the ocean, and exposed them to the influence of a perpetual sun. But this, like every cause which we cannot discover, must remain only problematical; for nature has so many modes of operating, and we are as yet acquainted with so small a number of them, that our speculations beyond what we actually know, can at the best but reach to probable conjecture.

The Grenadines. This group of islands is the commencement of the second or western range; we sailed through them without stopping, so that their geological character must be taken from their general appearance, which was completely volcanic, having rocks rising perpendicularly out of the ocean, one of which is called, from its form, the organ rock, being composed of columns of basalt. The rocks are in general rugged, and so deranged, that their volcanic character could not be mistaken.

St. Vincent, like all the other volcanic islands, is composed of

a mixture of lava and cinders, in all proportions. South of Kingston, there appears to be more solid and porous lava, and less cinders than at the north. The Bay of Kingston has the appearance of being the remains of an ancient crater, the beds of lava inclining irregularly from the centre, at a considerable dip, as if they had been ejected from it. On every side, the rocks are aggregates of various kinds of roasted stones, cemented with cinders, and small atoms of scoria; and though many of the rolled rocks neither bear strong marks of fusion, nor resemble much recent lavas, yet they all have a family feature, and must be considered of volcanic origin. A substance like hornblend, with feldspar imbedded in it, forms the principal part of these rocks, which vary in colour, from nearly black to grey, the feldspar being generally crystallized, and frequently diaphanous, passing through the porous or scorious rocks without indications of having undergone much change. There are two principal modes by which the production of cinders or ashes may be accounted for; they may be thrown from the crater of a volcano during an eruption of lava, and in that case they consist of small pieces of scoria, pumice, &c. and are placed in strata of various thicknesses and colours, as if deposited by water; or they may be ejected from volcanoes nearly exhausted mixed with water and rocks, forming large beds or currents of an aggregate, which is in time cemented, and wears the appearance of a breccia. A third mode is, perhaps the eruption of lava into the sea, at the commencement of submarine volcanoes, when by means of the sudden cooling, the melted lava might crumble into small angular sand, and form beds of cinders. From Kingston to the north end of the island, the same alternation of cinders and solid lava obtains, forming steep precipices and narrow vallies, the wearing and excavation of which, by the mountain torrents, is facilitated by the prevalence of the cinders which increases as you approach the *Soufriere*, a name given in the West Indies, to spots which indicate the remains of a subsiding volcano, and whence hot sulphureous vapours are ejected through *fumerols*, depositing sulphur, and converting the surrounding aluminous rocks into alum-stone, as at Solfaterra near Naples.

The fumerols of this Soufriere are at present extinguished,

perhaps by the last irruption of cinders in 1812, when the crater threw forth a mixture of water, rocks, and cinders in a state approaching to ignition, resembling a current of lava; burning the woods, and filling all the channels of the little rivers that descend the mountain, and rising sometimes to the height of three or four hundred feet.

This irruption consisted of a great quantity of angular sand, the broken masses of roasted and vitrified rocks being mixed with loose angular pieces of all sizes, brittle, and crumbling under the hammer. These imbedded rocks are, 1st. A rock resembling a small and middling sized grained granite, roasted, with diaphanous feldspar. 2. A gray rock, in plates, like gneiss, but much altered by the fire. 3d. A feldspar and hornblend rock, the feldspar crystallized and diaphanous, with the appearance of having been roasted. 4th. A hornblend rock, crystalline, having a roasted appearance. 5th. A dark coloured rock, with a conchoidal, even, vitreous fracture, containing crystals of feldspar, some pieces so vitreous as to resemble pitch-stone, and porphyry running through all the gradations from a gray rock, scarcely vitrified, to a total vitrification, and thence to a porous scoria, not unlike pumice, with transparent crystals of feldspar, taking a deeper tinge of black in proportion to the degree of vitrification. 6th. A bluish rock with feldspar, and some black crystals, having all the appearance of compact lava. If one supposes that volcanic action tends to form large cavities under the places whence the lava, &c. issues, and that one, or more, of these cavities, where the combustible materials are exhausted, becomes filled with water, while other cavities, where these materials still remain, are filled with lava, &c. it would appear only necessary to unite the contents of two such caverns to produce all the effects of an irruption of cinders.

St. Lucia I passed, and only observed it from the sea. It has the appearance of being rugged and steep, with few vallies, and perhaps not the same proportion of cinders as the other islands. It has an extensive soufriere at the foot of two sharp conical hills.

Martinico. On the south side of the Bay of Port Royal, at Lamentine and Point De Bourg, there is a compact rock, dividing like trap, and decomposing into balls, which fall into a strong red clay, making an excellent soil; it rests upon a bed of cinders, and assumes in some places the form of basaltic columns.

About Port Royal, and the hill to the north of it, there is a current of solid lava, which has formed the north side of the bay, decomposing into balls, and forming a strong soil.

From Point Negro to St. Peter's the coast consists principally of cinders, mixed with lava rocks. Under the fort at the south end of St. Peter's, and near the Botanic Garden on the north side, there appears a mass of the same rock as occurs at Port Royal, approaching the basaltic form, and is full of vitreous crystals of feldspar.

The region lying across the island from St. Peters to Bass-point, is composed, wholly to the summit of the land, of cinders and pumice, with vegetable earth lying between the beds of cinders, alternating two or three times. Descending to the windward part of the island, the cinders are found mixed with detached pieces of compact lava, and other rocks, with large blocks of pumice, till you come to the flat country, which is covered with cinders. It is natural to suppose that the greatest part of the light substances, such as cinders, pumice stones, &c. should go to leeward; yet in the irruption of St. Vincent, in 1812, very fine cinders fell on the decks of vessels three or four hundred miles to windward, supposed to have been carried by a counter current of air, in the upper regions of the atmosphere.

Dominica is in general composed of cinders, with rolled and detached pieces of lava, pumice, &c. disseminated so as to form a kind of pudding stone, containing five times more of the cement than of the detached pieces. Where compact lava appears, it is in masses, seldom in currents, and generally covering the cinders.

The soufriere is in the bottom of a bay, at the south end of the island, and has all the appearance of being the remains of

an ancient crater: it is extensive, and furnishes at times both sulphur and alum, the quantity of alum rocks being considerable. There are other fumeroles in the interior of the island, which might furnish alum and sulphur.

On the top of the mountain, as you cross the island, there is a lake, having all the appearance of being an old crater, about which the quantity of loose stones is greater, and of cinders less, than on the coast.

A bed of coral and madrepore limestone, with shells, lies horizontally on a bed of cinders, about two or three hundred feet above the level of the sea, at Rousseau, and is covered with cinders to a considerable height.

Basseterre in Guadaloupe. On landing at St. Rose, at the north end, the red clay occurs as at Lamentine in Martinico, and is the result of the decomposition of the same compact blue basaltic rock, which appears to prevail over all the low country, dividing Grandterre from Basseterre. This blue rock is placed on a bed of cinders, and takes the form of an irregular basalt.

From St. Rose to Delahay, along the coast, the head lands appear of solid rocks, like currents of lava, separated by narrow sandy vallies, the sand being partly white and calcareous, formed by the trituration of shells; and partly black, ferruginous, and crystalline, from the decomposition of solid lava: this ferruginous sand is found in all volcanic countries, and frequently is a distinguishing characteristic of volcanic regions. At a head land, about one league north of Pigeon Island, called Malendure, there occurs a current of red cinders, filled with small prisms of red stilbite, and having loose pieces of lava mixed, containing also the red stilbite; this makes the third locality where I found the red stilbite, two of them, viz. Vesuvius and this, are undoubtedly volcanic, the other, the valley of Falsa, in the Tirol, has been supposed to be of Neptunian origin by the Wernerians. Along the coast of Basseterre is found a mixture of cinders and lava, but more solid lava in currents, than in the other islands.

About six leagues to the top of the cone, where the crater

had been, and where the soufriere is now, I found a chasm or crack, in the mountain, which seemed to have been a crater, but which had been closed by some convulsion, where, by the removal of the middle, the sides had been impelled together with such force, as to break up the walls, and leave the whole in the greatest confusion. The fumerols are on the side of this crack, without any accumulation of sulphur, or alum rock, for these substances fall into the crack as fast as they are formed. The scenery is exceedingly rugged and wild; the rocks broken in immensely large masses, and irregularly thrown about in every direction. At the northern extremity of this crack lies what is called the cave, whence there issued about fifteen or twenty years ago, a flood of water and stones, which ran down the valley, at present called the valley of Faujas, in the utmost disorder. I am inclined to think that water only came from the crack, and that it ran over the mountain, sweeping in its course all the small stones and cinders, leaving those that were too large to be moved. This irruption of water was cool, and without any apparent connection with heat, though it was most probably ejected by the force of some elastic fluid.

Montserrat. I passed close to the leeward side of the island of Montserrat, but did not land. The south side had an appearance of being partly composed of solid rock, and the rest of the island might be supposed to be constituted of cinders mixed with loose rocks, as it consists of one mountain, the sides of which are furrowed by the rain, gently, and not in precipices, as would have been the case had there been many currents of solid lava, which circumstance, with the flatness of the coast, and the gradual ascent of the mountain, would seem to indicate a great proportion of cinders.

Nevis consists of one mountain in the middle, a truncated cone, I suppose about 2000 feet high; and one small elevation to the south, called Saddle-Hill, and another to the north called Round-Hill; the rest of the island is a gradual descent from these three hills to the sea. It is composed of large masses of rocks, and beds of cinders, gray, red, and black, of various degrees of solidity, from the pumice to the compact lava; the black crystals I take to be augite, or perhaps what

Werner calls the basaltic hornblend of the Cape de Gate in Spain, many of the rocks being like those found at that place. The white or glassy I take to be feldspar, which, with a black substance resembling hornblend, constitutes a great proportion of the rocks of the volcanic islands in the West Indies. The nodules which are found occur more frequently in the centre of other rocks, they are of a small compact grain like greenstone, and not unlike those rounded pieces found in granite.

About one mile and a half S. E. of Charleston, there is a soufriere almost extinct, which occupies about two or three acres of a level spot. One mile below, there is a hot spring, the water of which rises to 110 degrees of Fahrenheit, and is used as a medical bath; and on the edge of the sea, about half a mile distant, the heat of the earth is sufficient to make the water boil. To the north of Charleston there are likewise soufrieres, and there can be little doubt that on all the islands, there have been a number of soufrieres which are now extinct and wasted away.

St. Christopher. This island, near Basseterre, consists of beds of black, red, and gray cinders, varying in thickness from two inches to many feet, containing black and white crystals, resembling those found in the last cinder eruption of St. Vincent. The sand on the bay of Bassetere is mostly of the black iron kind, with scarcely any of the broken shells or madrepore rock. Along the coast to Old-Road, the formation is of cinders, with few detached rocks, and the same from Old-Road to Brimstone-Hill.

Brimstone Hill is a stratification of madrepore limestone, containing shells, at an angle of upwards of 50 degrees from the horizon, reposing upon a bed of volcanic cinders, and partly covered by volcanic eruptions, making a fine specimen of the alternation of the Neptunian and volcanic formation, which, for aught we know, may be repeated twenty or thirty times in the foundation of these islands, as every current of lava that runs into the sea is liable to be covered with corals, madrepores, &c. and afterwards recovered with lava, until it comes above the surface of the sea.

On the south end, above Sandy Point, there is more pumice

stone, and at a point a little north there appear to be solid masses of compact rock, which look like currents of lava. From Sandy Point to Deep Bay, the rocks which occur are those mixed with cinders of a black colour, and full of glassy or transparent crystals.

St. Eustatia is formed of two hills that appear to have been both craters of volcanoes; the western one is more ancient, and is filled up with earth, &c.; the eastern one is higher, and appears to be more recent, the crater being only partially filled. The space between these two hills is filled with cinders, forming a plain with a bay on each side; the one to the leeward is the harbour, on the edge of whieh stands the town.

On the south-east side of the large hill, towards St. Christopher, there is a stratification of madrepore limestone, alternating with beds of shells, similar to those found at present in the sea. The whole of this marine deposition dips to the south-west at an angle of upwards of 45 degrees from the horizon, resting upon a bed of cinders, full of pumice and other volcanic rocks, and is immediately covered by a bed of madrepore, sand and cinders, mixed together, with blocks of volcanic rocks so disseminated that there can be no doubt of the volcanic origin of the substance above and below the maprepore rock, which may be from five to six hundred yards thick. Part of this madrepore rock is changed into silex, having the part that surrounded the animal converted into chalcedony. A considerable quantity of gypsum is found near the same place, in a crystalline state.

Saba. This little island seems to finish the volcanic formation, and consists of one mountain, rather rougher and more rugged than St. Eustatia, but apparently of nearly the same kind of rocks.

The foregoing description of the volcanic islands may perhaps authorize the following general remarks.

1st. That there is a great similarity in the substances ejected, which are marked by a family feature running through all the rocks, cinders, &c. of the different islands; and it is to be observed that the proportion of cinders, pumice, and other

light substances, is much greater than of the solid lavas, which are but thinly scattered; also that the cinders are always the lowest stratum on a level with the sea; and the masses of solid lava, near that level, repose on a bed of cinders, in every place where I had access to them.

2d. The madrepore and coral rocks, mixed with shells, partly similar to those found at present in the sea, are found in many places alternating with the cinders, and other volcanic rocks, presenting much the appearance of the whole having been ejected from the bottom of the ocean.

3d. The direction of the islands, running from north to south, a little easterly, corresponds with the direction of the strata of those stratified islands, lying to the eastward: such as Barbadoes, St. Bartholomew, &c. which should seem to support the supposition, that the seat of combustion occupies a stratified substance, running parallel to the general stratification of the surrounding rocks.

4th. In all the islands there are one or more soufrieres, all of which form alum rocks, and deposit sulphur, proving that sulphur is one of the ingredients that support the combustion, and perhaps giving strength to the supposition, that whatever may have been the original cause of the combustion, that cause is uniform, and the same through all the islands.

5th. In the late eruption of cinders, there was a great quantity of stones thrown out, exhibiting no appearance of having ever been in a state of fusion, but only roasted by a considerable heat; most of these rocks have every appearance of belonging to the primitive class, by their crystalline structure, and the position of their component parts: from which it would appear reasonable that the following conjectures may be hazarded.

1st. That the islands were probably thrown up from the bottom of the ocean.

2d. That the seat of combustion is more probably in a substance stratified, and that sulphur is one of the combustible ingredients.

3d. That the substance so stratified is most probably

primitive, and that consequently the combustion is in the primitive region covered by the transition, which forms the islands of the eastern group.

Art. XVI. *On the original Formation of the Arabic Digits.*

Admitting the probability of the conjectures of the author of the third article in No. II, respecting the original formation of the Arabic digits,' 1, 2, 3, 4, 5, 6, 8, 0, founded on the data there premised, may we not suppose it more likely that the Arabians would have formed the remaining digits, from different compounds of the inferior numbers, rather than that they would have gone aside (according to the hypothesis of the author of Art. 13, No. III) and have had recourse to the Greeks for the formation of 7, and 9, or have substituted the Greek figures for their own, on account of the supposed awkwardness of their compositon? For as the conjectures of the author of Art. 3, respecting the formation of 2, 3, 4, 5, 6, and 8, cannot but be admitted as very ingenious, and the remaining two digits may be formed after a similar manner, is it not much more reasonable to assume, that they were all formed after the same method? otherwise we are left to institute the enquiry, on what sufficient grounds the Arabians should have borrowed from the Greeks the formation of those two digits, when they could have formed them themselves with as much ease as they had formed any of the others.

Having been but lately become acquainted with the *Journal of Science, &c.* after the perusal of Art. 3, No. II, and Art. 18, No. III, it occurred to me, that the following would be the original formation of the digits in question, 7, and 9, following the plan proposed in Art. 3.

7, is first a perpendicular I, which with a straight line making a right angle with this perpendicular, becomes ┌ and with the addition of a line parallel to the first line is ┌┐

and this hurried and rounded in writing, is at length 7; it being much easier to write a line inclined /, than a perpendicular line I.

9, is first a square □, which, by producing the side on the right hand, becomes ᑫ, and this finally, when rounded, becomes 9.

May 15, 1818.

Art. XVII. *History of Dr. Brewster's Kaleidoscope, with Remarks on its supposed resemblance to other combinations of plain Mirrors.*

As this instrument has excited great attention, both in this country and on the Continent, we have no doubt that our readers will take some interest in the history of the invention. In the year 1814, when Dr. Brewster was engaged in experiments on the polarisation of light by successive reflexions between plates of glass, which were published in the Philosophical Transactions for 1815, and honoured by the Royal Society of London with the Copley Medal, the reflectors were in some cases inclined to each other, and he had occasion to remark the circular arrangement of the images of a candle round a centre, or the multiplication of the sectors formed by the extremities of the glass plates. In repeating, at a subsequent period, the experiments of M. Biot on the action of fluids upon light, Dr. B. placed the fluids in a trough formed by two plates of glass cemented together at an angle. The eye being necessarily placed at one end, some of the cement which had been pressed through between the plates, appeared to be arranged into a regular figure. The symmetry of this figure being very remarkable, Dr. B. set himself to investigate the cause of the phenomenon, and in doing this he discovered the leading principles of the kaleidoscope. He found that in order to produce perfectly beautiful and symmetrical forms, three conditions were necessary.

1. That the reflectors should be placed at an angle, which was an *even* or an *odd* aliquot part of a circle, when the object was regular; or the *even* aliquot part of a circle when the object was irregular.

6. That out of an infinite number of positions for the object both within and without the reflectors, there was only one position where perfect symmetry could be obtained, namely, by placing the object in contact with the ends of the reflectors.

3. That out of an infinite number of positions of the eye, there was only *one* where the symmetry was perfect, namely, as near as possible to the angular point, so that the circular field could be distinctly seen; and that this point was the only one out of an infinite number at which the uniformity of the light of the circular field was a maximum.

Upon these principles I r. B. constructed an instrument in which he fixed *permanently* across the ends of the reflectors, pieces of coloured glass, and other irregular objects, and he shewed the instrument in this state to some Members of the Royal Society of Edinburgh, who were much struck with the beauty of its effects. In this case, however, the forms were nearly permanent, and a slight variation was produced by varying the position of the instrument, with respect to the light. The great step however, towards the completion of the instrument, remained yet to be made, and it was not till some time afterwards, that the idea occurred to Dr. B. *of giving motion to objects, such as pieces of coloured glass, &c. which were either fixed or placed loosely in a cell at the end of the instrument.* When this idea was carried into execution, the kaleidoscope in its *simple form* was completed.

In this state, however, the kaleidoscope could not be considered as a general philosophical instrument of universal application; for it was incapable of producing beautiful forms, unless the object was nearly in perfect contact with the end of the reflectors.

The next, and by far the most important step of the invention, was therefore to remove this limitation by employing a draw tube and lens, by means of which beautiful forms could

be created from objects of all sizes, and at all distances from the observer. In this way the power of the kaleidoscope was indefinitely extended, and every object in nature could be introduced into the picture, in the same manner as if these objects had been reduced in size, and actually placed at the end of the reflectors.

When the instrument was brought to this state of perfection, Dr. Brewster was urged by his friends to secure the exclusive property of it by a patent, and he accordingly took out a patent for " a new optical instrument for creating and exhibiting beautiful forms." In the specification of his patent, he describes the kaleidoscope in two different forms. The first consists of two reflecting planes, put together according to the principles already described, and placed in a tube, with an eye-hole in the particular position which gives symmetry and a maximum uniformity of light, and with objects such as coloured glass, *placed in the position of symmetry, and put in motion either by a rotatory movement, or by their own gravity, or by both combined.* The second form of the instrument, described in the specification, is, when the tube containing the reflectors is placed in a second tube, at the end of which is a convex lens, which introduces into the picture objects of all magnitudes, and at every distance, as has been already described.

After the patent was signed, and the instruments in a state of forwardness, the gentleman who was employed to manufacture them under the patent, carried a kaleidoscope to shew to the principal London opticians, for the purpose of taking orders from them. These gentlemen naturally made one for their own use, and for the amusement of their friends; and the character of the instrument being thus made public, the tinmen and glaziers began to manufacture the detached parts of it, in order to evade the patent; while others manufactured and sold the instrument complete, without being aware that the exclusive property of it had been secured by a patent.

In this way the invasion of the patent right became general

among that class of individuals against whom the law is seldom enforced but in its terrors. Some workmen of a higher class were encouraged to piracy by this universal opposition to the patent; but none of the respectable London opticians would yield to the clamours of their customers, to encroach upon the rights of an inventor, to whom they were at least indebted for a new and a lucrative article of trade.

In order to justify these piratical proceedings, it became necessary to search out some combinations of plain mirrors, which might be supposed to have some resemblance to Dr. Brewster's instrument; and it would have been strange indeed if some theorem or experiment had not been discovered, which could have been used to impose upon the great crowd who are entirely ignorant of the principles and construction of optical instruments. There never was a popular invention, which the labours of envious individuals did not attempt to trace to some remote period; and in the present case, so many persons had hazarded their fortunes and their characters, that it became necessary to lay hold of something which could be construed into an anticipation of the kaleidoscope.

The first supposed anticipation of the kaleidoscope was found in Prop. XIII. and XIV. of Professor Wood's Optics, where that learned author gives a mathematical investigation of the number and arrangement of the images formed by two reflectors, either inclined or parallel to each other. This theorem assigns no position either to the eye or to the object, and does not even include the principle of inversion, which is absolutely necessary to the production of symmetrical forms. The theorem is true, whatever be the position of the object or of the eye. In order to put this matter to rest, Dr. Brewster wrote a letter to Professor Wood, requesting him to say if he had any idea of the effects of the kaleidoscope when he wrote those propositions. To this letter Dr. B. received the following handsome and satisfactory answer.

"*St. John's, May 19th*, 1818.

"Sir,—The propositions I have given relating to the number of images formed by plane reflectors inclined to each other,

contain merely the mathematical calculation of their number and arrangement. *The effects produced by the kaleidoscope were never in my contemplation.* My attention has for some years been turned to other subjects, and I regret that I have not time to read your Optical Treatise, which I am sure would give me great pleasure. I am, Sir, your obedient humble servant,

J. WOOD."

The next supposed anticipation of the kaleidoscope was an instrument proposed by Mr. Bradley in 1717. This instrument consists of two large pieces of silvered looking-glass, *five inches wide* and *four inches high*, jointed together with hinges, and opening like a book. These plates being set upon a geometrical drawing, and the eye being placed in front of the mirrors, the lines of the drawing were seen multiplied by repeated reflections. This instrument was described long before by Kircher, and did not receive a single improvement from the hands of Bradley. It has been often made by the opticians, and was principally used for multiplying the human face, when placed between the mirrors; but no person ever thought of applying it to any purpose of utility, or of using it as an instrument of rational amusement, by the creation of beautiful forms. From the very construction of the instrument indeed, it is quite incapable of producing any of the singular effects exhibited by the kaleidoscope. It gives, indeed, a series of reflected images arranged round a centre; but so does a pair of looking-glasses placed angularly in an apartment, and so do the pieces of mirror glass with which jewellers multiply the wares exhibited at their windows. It might therefore be as gravely maintained, that any of these combinations of mirrors was a kaleidoscope, as that Bradley's pair of plates was an anticipation of that instrument. As the similarity between the two has been maintained by ignorant and interested individuals, we shall be at some pains to explain to the reader the differences between these two instruments; and we shall do this, first, upon the supposition that the two instruments are applied to geometric lines upon paper.

1. In Bradley's instrument, the length is less than the breadth of the plates.	1. In the kaleidoscope, the length of the plates must be four, or five, or six times their breadth.
2. Bradley's instrument cannot be used with a tube.	2. The kaleidoscope, cannot be used without a tube.
3. In Bradley's instrument, from the erroneous position of the eye, there is a great inequality of light in the sectors, and the last sectors are scarcely visible.	3. In the kaleidoscope, the eye is placed so that the uniformity of light is a maximum, and the last sectors are distinctly visible.
4. In Bradley's instrument, the figure consists of elliptical, and consequently unequal sectors.	4. In the kaleidoscope, all the sectors are equal, and compose a perfect circle, and the picture is perfectly symmetrical.
5. In Bradley's instrument, the unequal sectors *do not unite*, but are all separated from one another by a space equal to the thickness of the mirror glass.	5. In the kaleidoscope, the equal sectors all unite into a complete and perfectly symmetrical figure.
6. In Bradley's instrument, the images reflected from the first surface interfere with those reflected from the second, and produce a confusion and overlapping of images entirely inconsistent with symmetry.	6. In the kaleidoscope, the secondary reflections are entirely removed, and therefore no confusion takes place.
7. In Bradley's instrument, the defects in the junction of the plates are all rendered visible by the erroneous position of the eye.	7. In the kaleidoscope, the eye is placed so that these defects of junction are invisible.

The reader will observe, that in this comparison the two instruments are supposed to be applied to *geometric lines upon paper*, and that this was *the only purpose* to which Bradley ever thought of applying his mirrors; yet the kaleidoscope is in every respect a superior instrument, even for that inferior purpose, and gives true symmetrical forms, which the other instrument is incapable of doing.

In the comparison which has now been made, we have

degraded the kaleidoscope, by contrasting its effects with those which Bradley's instrument is capable of producing, for these effects are not worth the looking at. When we attempt to employ Bradley's instrument to produce the effects which have been so much admired in the kaleidoscope, namely, to produce beautiful forms from transparent or opaque coloured objects contained in a cell, and at the end of the reflectors, it fails so entirely, that no person has succeeded in the attempt. It is indeed quite impossible to produce by it the beautiful and symmetrical forms which the kaleidoscope displays. Had this been possible, Dr. Brewster's patent might have been invaded with impunity by every person who chose to manufacture Bradley's instrument; but this was never tried,* and for the best of all reasons, because nobody would have purchased it.

We trust, that no person who wishes to judge of this subject with candour, will form an opinion without having *actually seen and used* the instrument proposed by Bradley. Let any person take Bradley's plates, and, having set them at an angle of 30° or 22½°, place them upon a cell containing fragments of coloured glass, he will infallibly find that he cannot produce a picture of any symmetry or beauty. The disunion of the sectors, the darkness of the last reflections, and the enormous deviation from symmetry, towards the centre of the figure, will convince him, if he required conviction, that the instrument is entirely useless as a kaleidoscope. To those, however, who are not capable, either for want of knowledge, or want of time, to make such a comparison, we may present the opinion of three of the most eminent natural philosophers of the present day,

* In illustration of this argument, we may state the following fact. Mr. Carpenter of Birmingham, being anxious to evade Dr. Brewster's patent, at a time when the manufacture of the patent kaleidoscope was in the hands of another person, attempted to construct instruments in imitation of Bradley's. After exercising his ingenuity for some time, he abandoned the attempt as impracticable, and set off for Scotland for the purpose of offering his services in manufacturing the patent instrument.

viz. the celebrated Mr. Watt, Professor Playfair, and Professor Pictet.

"It has been said here," says Mr. Watt, "that you took the idea of the kaleidoscope from an old book on gardening. My friend, the Rev. Mr. Corrie, has procured me a sight of the book. It is Bradley's Improvements of Planting and Gardening. London, 1731, part 2d. chap. 1st. It consists of two pieces of looking glass of equal bigness, of the figure of a long square, five inches long and four inches high, hinged together, upon one of the narrow sides, so as to open and shut like the leaves of a book, which, being set upon their edges upon a drawing, will shew it multiplied by repeated reflections. This instrument I have seen in my father's possession 70 years ago, and frequently since, but what has become of it I know not. In my opinion, the application of the principle is very different from that of your kaleidoscope."

The following is Professor Playfair's opinion:

Edinburgh, 11*th May*, 1818.

"I have examined the kaleidoscope invented by Dr. Brewster, and compared it with the description of an instrument which it has been said to resemble, constructed by Bradley in 1717. I have also compared its effect with an experiment to which it may be thought to have some analogy, described by Mr. Wood in his Optics, Prop. 13 and 14.

"From both these contrivances, and from every optical instrument with which I am acquainted, the kaleidoscope appears to differ essentially both in its effect and in the principles of its construction.

"As to the effect, the thing produced by the kaleidoscope is a series of figures presented with the most perfect symmetry, so as always to compose a whole, in which nothing is wanting and nothing redundant. It matters not what the object be to which the instrument is directed, if it only be in its proper place the effect just described is sure to take place, and with an endless variety. In this respect, the kaleidoscope appears to be quite singular among optical instruments. Neither the

instrument of Bradley, nor the experiment or theorem in Wood's book, have any resemblance to this; they go no further than the multiplication of the figure.

"Next, as to the principle of construction, Dr. Brewster's instrument requires *a particular position of the eye of the observer, and of the object looked at,* in order to its effect. If either of these is wanting, the symmetry vanishes, and the figures are irregular and disunited. In the other two cases, no particular position, either for the eye or the object, is required.

"For these reasons, Dr. Brewster's invention seems to me quite unlike the other two. Indeed, as far as I know, it is quite singular among optical instruments; and it will be matter of sincere regret, if any imaginary or vague analogy, between it and other optical instruments, should be the means of depriving the Doctor of any part of the reward to which his skill, ingenuity, and perseverance, entitle him so well.

JOHN PLAYFAIR,
Professor of Natural Philosophy in the University of Edinburgh.

"P. S.—Granting that there were a resemblance between the kaleidoscope and Bradley's instruments, in any of the particulars mentioned above, the introduction of coloured and moveable objects, at the end of the reflectors, is quite peculiar to Dr. Brewster's instrument. Beside this, a circumstance highly deserving of attention, is the use of two lenses and a draw tube, so that the action of the kaleidoscope is extended to objects of all sizes, and at all distances from the observer, and united, by that means, to the advantages of the telescope.

J. P.'

Professor Pictet's opinion is stated in the following letter:

"SIR,

"Among your friends, I have not been one of the least painfully affected by the shameful invasion of your rights as an inventor, which I have been a witness of lately in London. Not only none of the allegations of the invaders of your patent, grounded on a pretended similarity between your kaleidoscope

and Bradley's instrument, or such as Wood's or Harris' theories might have suggested, appear to me to have any real foundation; but, I can affirm, that neither in any of the French, German, or Italian authors, who, to my knowledge, have treated of optics, nor in Professor Charles' justly celebrated and most complete collection of optical instruments at Paris, have I read or seen any thing resembling your ingenious apparatus, which from its numberless applications, and the pleasure it affords, and will continue to afford, to millions of beholders of its matchless effects, may be ranked among the most happy inventions science ever presented to the lovers of rational enjoyment.

M. A. Pictet,
Professor of Natural Philosophy in the Academy of Geneva."

To Dr. Brewster.

The propositions in Harris' Optics relate, like Professor Wood's, merely to the multiplication and circular arrangement of the apertures or sectors formed by the inclined mirrors, and to the progress of a ray of light reflected between two inclined or parallel mirrors; and no allusion whatever is made, in the propositions themselves, to any instrument. In the proposition respecting the multiplication of the sectors, the eye of the observer is never once mentioned, and the proposition is true if the eye has an infinite number of positions; whereas, in the kaleidoscope, the eye can only have one position. In the other proposition, (Prop. XVII.) respecting the progress of the rays, the eye and the object are actually stated to be placed *between the reflectors;* and even if the eye had been placed without the reflectors, as in the kaleidoscope, the position assigned it, at a great distance from the angular point, is a demonstration that Harris was *entirely ignorant of the positions of symmetry either for the object or the eye,* and could not have combined two reflectors so as to form a kaleidoscope for producing beautiful or symmetrical forms. The *only practical part* of Harris' propositions is the 5th and 6th scholia to Prop. XVII. In the 5th scholium he proposes a sort of catoptric box or cistula, known long before his time, composed of four mirrors,

arranged in a most unscientific manner, and containing opaque objects *between the speculums.* "Whatever they are," says he, when speaking of the objects, "the upright figures between the speculums should be slender, and not too many in number, otherwise they will too much *obstruct the reflected rays from coming to the eye.*" This shews in a most decisive manner, that Harris knew nothing of the kaleidoscope, and that he has not even improved the common catoptric cistula, which had been known long before. The principle of inversion, and the positions of symmetry, were entirely unknown to him. In the 6th scholium, he speaks of rooms lined with looking-glasses, and of luminous amphitheatres, which, as the Editor of the Literary Journal observes, have been described and figured by all the old writers on optics.*

The persons who have pretended to compare Dr. Brewster's kaleidoscope with the combinations of plain mirrors described by preceding authors, have not only been utterly unacquainted with the principles of optics, but have not been at the trouble either of understanding the principles on which the patent kaleidoscope is constructed, or of examining the construction of the instrument itself. Because it contains two plain mirrors, they infer that it must be the same as every other instrument that contains two plain mirrors, and hence the same persons would, by a similar process of reasoning, have concluded that a telescope is a microscope, or that a pair of spectacles, with a double lens is the same as a telescope or a microscope, because all these instruments contain two lenses. An astronomical telescope differs from a compound microscope only in having the lenses placed at different distances. The progress of the rays is exactly the same in both these instruments, and the effect in both is produced by the enlargement of the angle subtended by the object. Yet surely there is no person so

* The reader is requested to examine carefully the propositions in Harris' Optics, which he will find reprinted in the Literary Journal, No. 10. He will then be convinced, that Harris placed both the eye and the object between the mirrors, an arrangement which was known 100 years before his time.

senseless as to deny that he who first combined two lenses in such a manner as to discover the mountains of the moon, the satellites of Jupiter and Saturn, and all the wonders of the system of the universe, was the author of an original invention. He who produces effects which were never produced before, even by means which have been long known, is unquestionably an original inventor; and upon this principle alone can the telescope be considered as an invention different from the microscope. In the case of the kaleidoscope, the originality of the invention is far more striking. Every person admits that effects are produced by Dr. Brewster's instrument, of which no conception could have been previously formed.

All those who saw it, acknowledged that they had never seen any thing resembling it before; and those very persons who had been possessors of Bradley's instrument, who had read Harris's Optics, and who had used other combinations of plain mirrors, never supposed for a moment, that the pleasure which they derived from the kaleidoscope had any relation to the effects described by these authors.

No proof of the originality of the kaleidoscope could be stronger than the sensation which it created in London and Paris. In the memory of man, no invention, and no work, whether addressed to the imagination or to the understanding, ever produced such an effect. A universal mania for the instrument seized all classes, from the lowest to the highest, from the most ignorant to the most learned, and every person not only felt, but expressed the feeling, that a new pleasure had been added to their existence.

If such an instrument had ever been known before, a similar sensation must have been excited, and it would not have been left to the ingenuity of the half learned and the half honest to search for the skeleton of the invention among the rubbish of the 16th and 17th centuries.

The individuals who have been most eager in this search, did not, perhaps, calculate the degree of mischief which they have done to those who have been led, upon their authority, to encroach upon the rights of others, and thus subject themselves to

very serious consequences. The delay which has taken place in commencing legal proceedings, has not arisen from any doubt of the complete originality of the kaleidoscope, and of the defensibility of the patent. As soon as the patentee has made himself acquainted with the circumstance of the individuals who have invaded his patent, with the channels through which they have exported their instruments, and with the amount of the damage which they have done, he will seek for that redress which the law never fails to afford in cases of notorious and unprovoked piracy. We are well assured, that it never was the intention or the wish of Dr. Brewster to interfere with the operations of those poor individuals who have gained a livelihood from the manufacture of kaleidoscopes. We know that it will always be a source, of no inconsiderable gratification to him, that he has given employment to thousands of persons, whom the pressure of the times had driven into indigence; and even if a decision in favour of his patent were given, he would never think of enforcing it, excepting against that class of opulent pirates who had been actuated by no other motive but the exorbitant love of gain, in wantonly encroaching upon the property of another.

The patent kaleidoscopes are now made in London, under Dr. Brewster's sanction, by Messrs. P. and. G. Dollond, W. and S. Jones, Mr. R. B. Bate, Messrs. Thomas Harris and Son, Mr. Bancks, Mr. Berge, Mr. Thomas Jones, Mr. Blunt, Mr. Schmalcalder, Messrs. Watkins and Hill, and Mr. Smith. An account of the different forms in which these ingenious opticians have fitted up the kaleidoscope, and of the new contrivances by which they have given it additional value, will be given in Dr. Brewster's Treatise on the Kaleidoscope, now in the press. The public will see, from the examination of these instruments, how much they have been imposed upon by spurious imitations, sold at the most exorbitant prices, and made by individuals entirely ignorant, not only of the principles and construction of the instrument, but of the method of using it.

Art. XVIII. *An Account of the New Alkali lately discovered in Sweden.*

The discovery made by M. Arfwedson of a new alkali, and announced in the last Number of the Journal, has been abundantly confirmed by the researches of other chemists. Its importance has drawn the attention of the whole chemical world, and much new information relative to its nature and its sources, has since been added, which we shall endeavour to comprise in the following account of this body.

Lithia (the name given to the new alkali) was first found in the petalite, a mineral from the mine of Utoen in Sweden. It may be obtained very readily by fusing the mineral with potash, dissolving the whole in muriatic acid, evaporating to dryness, and digesting in alcohol: the muriate of lithia being very soluble in that fluid, is taken up, whilst the other salts remain, and by a second evaporation and solution, is obtained perfectly pure.

The muriate is itself a very characteristic salt of the alkali. It may easily be decomposed by carbonate of silver, and the carbonate treated with lime yields pure lithia.

The exact quantity of lithia in the petalite is doubtful, but it cannot contain much more than five per cent. A more abundant source has however been found in the Triphane or Spodumene, which according to M. Arfwedson, who also first pointed out in it the existence of lithia, contains eight per cent. of the new alkali. The same chemist has likewise ascertained its existence in another mineral from Utoen which is called crystallised lepidolite in the proportion of four per cent.

The pure alkali is very soluble in water, has a very acrid caustic taste, like the other fixed alkalies, and acts powerfully on blue vegetable colours. When heated on platinum, it acts on it. It has a strong affinity for acids, and a very high neutralising power, even surpassing that of magnesia. Its solution precipitates the earthy and metallic salts, nearly as solutions of the other alkalies do.

Placed in the Voltaic circuit, Sir H. Davy shewed that it

was decomposed with the same phenomena as the other alkalies. A portion of its carbonate being fused in a platinum capsule, the platinum was rendered positive and a negative wire brought to the upper surface. The alkali decomposed with bright scintillations, and the reduced metal being separated, afterwards burnt. The small particles which remained a few moments before they were reconverted into alkali, and allowed a short examination, were of a white colour, and very similar to sodium. A globule of quicksilver made negative, and brought into contact with the alkaline salt, soon became an amalgam of lithium, and had gained the power of acting on water, and evolving hydrogen, an alkaline solution resulting.

The chloride of lithium obtained by evaporating the muriate to dryness, and fusing it, is a white semi-transparent body, analagous in its appearance to the chlorides of potash and soda, but very different from them in its general properties. It is extremely deliquescent, whereas they are not so: in this respect it almost equals muriate of lime. Its solution crystallises with great difficulty, but by evaporation affords minute needle-form crystals. It is very soluble in alcohol, but the chlorides of potash and soda very little so. Its solution, or the moist salt, has the property of tinging the flame of alcohol of a fine red, somewhat like strontian, but the other alkaline muriates have not this power. It fuses below a red heat, and when heated powerfully in the open air, it gradually loses chlorine, absorbs oxygen, and becomes strongly alkaline.

All its salts are very fusible, but in some cases a singular degree of insolubility belongs to them. The nitrate is a very soluble salt, deliquescent, and capable of crystallising in rhomboids. It has a very aigre taste: heated it readily fuses, and is then decomposed with the same phenomena as nitre.

The sulphate of lithia is a salt which crystallises readily in small rectangular prisms; they are perfectly white, and possess much lustre; have a saline taste, very different to potash or soda; are more soluble in water than sulphate of potash;

perhaps not so soluble as sulphate of soda: the crystals contain no water; they fuse and become very liquid below a red heat; their solution does not precipitate the muriate of platina, nor is it precipitated by tartaric acid. M. Vauquelin gives an experiment on its constitution, the result of which is as follows:*

Sulphuric acid - -	69.18
Lithia - - -	30.82
	100.00

The sub-carbonate of lithia is but little soluble in water, and effloresces in the air. It may even be precipitated from its sulphate by adding a strong solution of carbonate of potash to it. It is readily fusible, and when fused, requires repeated additions of water with boiling to dissolve it again. Cold water dissolves about one one-hundreth part of its weight of this salt, and the solution acts powerfully on vegetable colours and effervesces with acids. According to Vauquelin, it attracts carbonic acid very rapidly from the atmosphere.

The carbonate, heated on platinum, acts on it almost as powerfully as the fixed alkaline nitrates. It separates ammonia from its combinations, but is decomposed by lime and barytes, and rendered caustic.

The solution of the carbonate precipitates the muriate of lime, the sulphates of magnesia and alumina, and the salts of copper, silver, and iron, just as the other alkaline carbonates do; but it does not precipitate the muriate of platinum, as is the case with the sub-carbonate of potash.

The tartrate of lithia is an efflorescent salt; the acetate one that on being evaporated, takes the state and consistence of gum or syrup.

The sulphuret formed by M. Vauquelin, appeared in all respects, similar to the fixed alkaline sulphurets; except in the larger proportion of sulphur thrown down by acids.

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* There is an error in the calculations in M. Vauquelin's paper, the given constituents of 100 parts, if added together, making 101. The proportions deduced from the experiment, are correctly as above, at least to the second decimal place.

With respect to the proportions of the elements of the alkali, they do not appear exactly determined. Mr. Arfwedson states, that lithia contains 43.9 per cent. of oxygen. M. Vauquelin concludes that it contains 43.5 per cent.; but in consequence of the error mentioned in the preceding note, the last number is not correct, and if deduced from that experiment, the oxygen would be 44.84 per cent.

Art. XIX. *Observations relating to the Operations undertaken to determine the Figure of the Earth. By* M. Biot, *of the Academy of Sciences.*

The distinguished author of this pamphlet, which has just been published in Paris, is too favourably known to our scientific readers, to require any introduction or eulogy, and the subject he treats of is so well set forth in a preceding article of this Number of our Journal, by an eminent foreign correspondent, that we can find little to add from the present pages. Our task on the present occasion, is the most grateful we have ever had to perform—that of recording a manly and liberal avowal of the hospitable reception which the author found upon our shores, a just tribute of applause to the scientific eminence of our countrymen, and a most liberal acknowledgment of the assistance which he received in his important philosophical investigations. We hope that this paper will be received as a record of the amity which really exists among the men of science of the two countries, and of their honourable inclination to avow and protect it from the gales of political animosity. We trust too, that it shews a desire in the high quarter whence it comes, of duly acknowledging the merits, value, and originality of British talents, as opposed to the paltry and absurd jealousies which have more than once been suffered to stain the pages of continental writers.

In the following animated exordium, which it would be wrong

either to translate or abridge, M. Biot takes a happy view of the rapid increase of scientific discovery, and of the importance of literary and learned societies,

"Lorsque, sur une des tours de Florence, Galilée, il y a deux siècles, expliquait à un petit nombre de personnes, dans des entretiens presque mystérieux, ses découvertes nouvelles sur les lois de la pesanteur, le mouvement de la terre et la figure des planètes, aurait-il jamais pu prévoir que ces vérités, alors méconnues et persécutées, seraient, après un si court intervalle considérées comme tellement importantes, et si généralement admirées, que les gouvernemens de l'Europe feraient entreprendre de grandes opérations et de lointains voyages pour le seul but de les étendre, d'en constater toutes les particularités; et que, par l'effet d'une propagation inespérée de toutes les connaissances, les résultats de ces travaux pourraient être offerts à l'intérêt public, dans des assemblées nombreuses, composées des classes les plus éminentes de la société! Tel est pourtant l'immense changement qui s'est opéré dans le sort des sciences depuis cette époque. Quand Galilée et Bacon parurent, après tant d'esprits sublimes que l'antiquité avait produits, ils trouvèrent la carrière des sciences encore vierge; car on ne saurait donner le nom de science à l'inutile amas de spéculations hypothétiques qui composait avant eux la philosophie naturelle. On avait voulu jusqu'alors deviner plutôt qu'étudier la nature: l'art de l'interroger et de lui faire révéler ses mystères n'était pas connu; ils le découvrirent. Ils montrèrent que l'esprit humain est trop faible et trop incertain pour s'avancer seul dans ce dédale de vérités; qu'il a besoin de s'arrêter sur des phénomènes rapprochés les uns des autres, comme l'enfant se repose sur les appuis qu'il rencontre lorsqu'il essaie ses premiers pas; et que, dans les circonstances multipliées où la nature lui offre à franchir de trop grands intervalles, il faut que, par des expériences industrieusement imaginées, il fasse naître sur sa route de nouveaux phénomènes qui assurent sa marche et l'empêchent de s'égarer. Telle a été la fécondité de cette méthode, qu'en moins de deux siècles, des découvertes sans nombre, des découvertes certaines, durables, ont éclaté dans toutes les parties des sciences, se sont commu-

niquées rapidement aux arts, à l'industrie qu'elles ont enrichie d'applications merveilleuses, et ont accru le trésor des connaissances humaines mille fois au-delà de ce qu'avait fait toute l'antiquité. Mais, ainsi étendues, les sciences excèdent les facultés d'un seul homme. Leur sphère immense ne peut plus être embrassée que par un grand corps litéraire qui dans son ensemble, comme dans un vaste sensorium, réunisse toutes les conceptions, toutes les vues, toutes les pensées ; qui, ne connaissant ni les infirmités humaines, ni la décadence des sens et de la vieillesse, toujours jeune, toujours actif, scrute incessamment les propriétés intimes des choses naturelles, découvre les forces qui y sont cachés et les offre enfin à la société tout élaborées et preparées pour les applications. Dans ce centre où toutes les opinions s'agitent et se combattent, nulle autorité ne peut prévaloir, si ce n'est celle de la raison et de la nature. La voix d'un Platon même ne saurait plus y faire écouter les rêves brillans de son imagination ; et le génie d'un Descartes, contraint de rester fidèle à la méthode d'observation et de doute qu'il avait lui-même créée, n'y produirait que des vérités sans mélange d'erreurs. Mais Platon, et Descartes, avec toute leur gloire, ne seraient encore que des élémens passagers de ce grand organe des sciences. Sa force survivrait à leur génie, et poursuivrait dans l'avenir le développement de leurs pensées. Telle est aujourd'hui la noble destination des sociétés savantes. La simultanéite et la durée que leur institution donne à des efforts mortels, complètent la puissance de la méthode expérimentale. Elles seules pouvaient désormais assurer la continuité du progrès des connaissances humaines ; seules elles pouvaient développer les grandes théories, et faire obtenir des résultats qui, par leur difficulté, par la diversité, la persévérance et l'étendue des travaux qu'ils exigent, n'auraient jamais été accessibles pour des individus."

Our author then proceeds to a review of the researches which have been undertaken to determine the magnitude and figure of the earth, the phenomena of gravitation at its surface, and its connection with the interior constitution of the globe. The first exact measure of a degree of the terrestrial meridian was made in France by Picard, in 1670. Two years afterwards, Richer, also a native of France, being sent for astronomical re-

searches to Cayenne, found that a pendulum which beat seconds at Paris, moved more slowly in proportion to his approach to the equator, and that as he receded from the equator towards the north, its vibrations were again accelerated. Newton, in his immortal "Principia," connected these observations with the law of attraction, and referred the variation of the pendulum to the influence of the form of the earth, which like Jupiter, Saturn, and other planets, turning upon an axis, is flattened at the poles; he conceived this form to result from the attraction of the parts of each planet, combined with the centrifugal force, occasioned by their rotatory motion. For this arrangement it was necessary to assume the fluidity of the globe, and Newton, pointed out the means of calculating the polar depression of a planet from the intensity of gravitation at its surface, and the rapidity of its rotation, supposing it homogeneous throughout. This calculation, as applied to the earth, gave a result differing a little from that obtained by Richer; the difference seemed to show that the density of the earth increased from the surface to the centre, as Clairault has since demonstrated.

M. Biot next adverts to the celebrated voyages of Bouguer, Godin, and la Condamine, in 1735, and of Clairault, Maupertuis, and le Monnier, undertaken with a view of measuring an arc on the meridian near the equator, and near the pole, and mentions the interest and importance given to this investigation by the Academy, in proposing to adopt the magnitude of the earth thus determined as the fundamental element of a general system of weight and measure. This act of the Academy "fut un des derniers qui précédèrent la funeste époque de nos grandes convulsions politiques. Toutes les institutions conservatrices de la civilisation et des lumières périrent; l'Académie périt avec elles. Mais de vrais savans ne se font pas répéter l'autorisation de faire ce qu'ils croient utile. Au milieu du désordre et des fureurs excités par l'anarchie populaire, MM. Delambre et Mechain, munis d'instrumens nouveaux que Borda leur avait créés, commencèrent et continuèrent, souvent au péril de leur vie, la mesure de la terre la plus étendue, la plus exacte que l'on eût jamais entreprise. Ils l'achevèrent aussi-bien, quoique non pas aussi aisément qu'ils l'auraient fait au sein de la paix la

plus profonde. La mesure du pendule ne fut point oubliée. Borda, qui avait tant fait pour perfectionner toutes les autres parties des observations, inventa pour cette expérience une méthode dont l'exactitude surpassait tout ce qu'on avait imaginé jusqu'alors, et n'a pas été surpassée depuis."

The unfortunate death of Mechain, and the difficulties encountered by Arago and our Author in pursuing these undertakings in Spain, with some other minor inquiries, bring our Author to the Trigonometrical Survey of this country by General Roy and his able successor Colonel Mudge, who measured several degrees of the terrestrial meridian with great accuracy. To connect these with the French operation the Bureau des Longitudes was desirous that the same instruments employed in Spain and France should be applied to the English arc. Our Author proceeds—

"Souhaiter une chose utile aux sciences, c'était avoir d'avance l'assentiment des savans d'Angleterre et l'approbation du gouvernement de ce pays éclairé. Ni l'un ni l'autre ne nous manquèrent. Le respectable sir Joseph Banks et son digne ami le Ch[er] Blagden nous assurèrent de toutes les facilités imaginables. Le ministre de l'intérieur, M. Lainé, près de qui toute chose utile, ou honorable, n'a que la possibilité pour limite, trouva dans les ressources de sa bienveillance les moyens de fournir à cette entreprise, et le bureau des longitudes voulut bien m'en confier l'exécution.

"Je partis de Paris au commencement du mois de mai de l'année dernière, emportant avec moi les appareils qui avaient servi sur les autres points de la méridienne, un cercle répétiteur de M. Fortin, une horloge astronomique et des chronomètres de M. Bréguet, enfin, tout ce qui était nécessaire pour les observations. Des ordres du gouvernement anglais, obtenus par l'intervention tutélaire de sir Joseph Banks, attendaient cet envoi à Douvres. Il me fut remis tout entier sous le sceau de la douane, sans droits, sans visite, absolument comme si je n'eusse pas changé de pays. Les mêmes soins en protégèrent le transport jusqu'à Londres, où il fut déposé chez sir Joseph Banks. Que ne puis-je peindre ce que je sentis en voyant pour

la première fois ce vénérable compagnon de Cook! Illustre par de longs voyages; remarquable par une étendue d'esprit et par une élévation de sentimens qui le font s'intéresser également aux progrès de toutes les connaissances humaines; possesseur d'un rang élevé, d'une grande fortune, d'une considération universelle, sir Joseph a fait de tous ces avantages le patrimoine des savans de toutes les nations. Si simple, si facile dans sa bienveillance, qu'elle semble presque, pour celui qui l'éprouve, l'effet d'un droit naturellement acquis; et en même temps si bon, qu'il vous laisse tout le plaisir, toute l'individualité de la reconnaissance. Noble exemple d'un protectorat, dont toute l'autorité est fondée sur l'estime, l'attachement, le respect, la confiance libre et volontaire; dont les titres consistent uniquement dans une bonne volonté inépuisable et dans le souvenir des services rendus; et dont la possession longue et non contestée fait supposer de rares vertus et une exquise délicatesse, quand on songe que tout ce pouvoir doit se former, se maintenir et s'exercer parmi des égaux."

This tribute of respect and gratitude to the President of the Royal Society is memorable for two reasons; as shewing that M. Biôt has entirely divested himself of that crooked jealousy which we have sometimes complained of in his otherwise illustrious countrymen; and as an *Eloge* without flattery, and true in the strictest sense of the word.

M. Biôt now proceeds to Edinburgh with Colonel Mudge, and afterwards with Captain Richard Mudge to the extreme northern point of the line. At Edinburgh and at Aberdeen he met with a reception worthy of the inherent hospitality of North Britons. Thence they embarked for Shetland—

"Nous restâmes long-temps en mer, retenus par des calmes ou par des vents contraires, regrettant de tout notre cœur la perte de tant de belles nuits que nous aurions pu si bien employer pour nos observations. Le sixième jour, nous laissâmes au loin sur notre gauche les Orcades et leurs montagnes rougeâtres, que ne dépassa point l'audace romaine; nous découvrîmes l'île de Faira, qui vit se briser sur ses rochers le vaisseau amiral de l'invincible flotte de Philippe. Enfin les pics de

Shetland nous apparurent dans leur nuages; et le 18 juillet nous prîmes terre, non loin de la pointe australe de ces îles, où les marées de l'Atlantique, heurtant celles qui viennent de la mer de Norwège, causent un soulèvement continuel et une éternelle tempête. L'aspect désolé du sol ne démentait pas ces approches. Ce n'étaient plus ces îles fortunées de l'Espagne, ces riantes contrées, ce jardin de Valence, où les orangers, les citronniers en fleur, répandent leurs parfums autour du tombeau d'un Scipion, ou sur les ruines augustes de l'ancienne Sagonte. Ici, en abordant, sur des rocs mutilés par les flots, l'œil n'aperçoit qu'une terre humide, déserte, couverte de pierres et de mousse; des montagnes décharnées que ruine l'inclémence du ciel; pas un arbre, pas un buisson dont la vue adoucisse cet aspect sauvage; çà et là quelques huttes éparses, dont les toits recouverts d'herbe laissent échapper dans le brouillard l'épaisse fumée dont elles sont remplies. En songeant à la tristesse de ce séjour, où nous allions rester exilés pendant plusieurs mois, nous nous dirigeâmes, non sans peine, à travers des plaines et des collines sans chemin, vers le petit assemblage de maisons de pierre qui forme la capitale appelée Lerwick. Là, nous pûmes commencer à sentir que les vertus sociales d'un pays ne doivent pas se mesurer sur ses apparences de pauvreté ou de richesse. Il est impossible d'imaginer une hospitalité plus franche, plus cordiale que celle qui nous accueillit. Des personnes qui ne connaissaient nos noms que depuis un instant, s'empressaient de nous conduire par-tout. Informées de l'objet de notre voyage, elles nous donnaient d'elles-mêmes tous les renseignemens qui pouvaient nous être utiles; elles les recueillaient pour nous, et nous les transmettaient avec le même intérêt que s'il se fût agi d'une affaire qui leur eût été personnelle."

At Unst Captain Mudge became unwell; and our Author persuaded him to return to a milder climate, and remained alone to complete his researches.

"Ce fut alors que, resté seul, je pus apprécier combien il était heureux pour moi d'être venu habiter chez M. Edmonston. La bienveillance de cet excellent homme semblait croître

avec la difficulté de ma position. Je ne pouvais observer seul, au cercle répétiteur, dont la manœuvre exige deux personnes, une qui suit l'astre, l'autre qui note les indications du niveau. M. Edmonston, qui s'intéressait à mes travaux autant que moi-même, me suggéra l'idée d'employer, pour cette dernière partie de l'observation, un jeune charpentier, qui nous avait déja donné des preuves de son intelligence et de son adresse en remontant notre observatoire; et qui, d'ailleurs, comme tous les paysans d'Ecosse et même de ces îles, savait fort bien lire, écrire et compter. Je suivis cet avis; et, ayant réduit la tâche de mon nouvel assistant à ce qu'elle pouvait être de plus simple, j'essayai de lui en donner quelques leçons peu de jours avant le départ du capitaine Mudge. Il réussit très-vite, et peut-être mieux qu'un aide plus savant n'aurait pu le faire; car il observait et marquait mon niveau avec toute la fidélité d'une mécanique; et, pour rien au monde, non pas même pour seconder mon impatience à observer, il n'aurait admis mes résultats comme bons, avant qu'ils fussent strictement dans les conditions que je lui avais prescrites, c'est-à-dire avant que la bulle du niveau fût parvenue à une parfaite immobilité. Toutefois, comme il faut bien se réserver quelques vérifications quand on veut faire d'un charpentier un astronome, j'avais, entre les nombres qu'il écrivait, certaines relations qu'il ne soupçonnait pas, et qui m'auraient indiqué ses erreurs s'il en avait commisses. Cela arriva quelquefois dans les commencemens; et il était toujours fort surpris que je pusse ainsi reconnaître et redresser une faute, que lui-même n'avait pas aperçues en la faisant, et que moi, je n'avais pas vu faire. Mais, au bout de quelques jours, ma science occulte n'eut plus aucune occasion de se montrer."

With this assistance M. Biôt completed his task; and as an apology for omitting his sprightly and intelligent remarks upon these northern barriers of the British dominions, we have the pleasure of presenting our readers with the concluding paragraphs, of this charming little narrative.

"Après deux mois de séjour je quittai ces îles, emportant des souvenirs pour toute ma vie. Un coup de vent de l'équinoxe me ramena à Edimbourg en cinquante heures. Ce pas-

sage brusque de la solitude au bruit du monde, de la simplicité patriarchale aux raffinemens de la civilisation et du luxe n'est pas sans attrait. Le colonel Elphinstone, par le plus obligeant accueil, me prouva que l'amitié n'était pas toute retirée aux îles Shetland. Ce fut alors qu'entièrement désoccupé de mes observations, je pus contempler à loisir tout ce que l'état social le plus avancé offre, dans ce pays, en institutions et en hommes; spectacle, à-la-fois consolant et triste, pour quiconque a passé sa vie au milieu des troubles du continent. Je vis un peuple pauvre, mais laborieux; libre, mais respectueusement soumis aux lois; moral et religieux sans âpreté, tolérant sans indifférence. Je vis des paysans apprendre à lire dans des livres où se trouvent des essais d'Addison et de Pope. Je vis les ouvrages de Johnson, de Chesterfield, et des plus agréables moralistes anglais, offerts en délassement à la classe moyenne du peuple: dans des coches d'eau, comme ailleurs, on y mettrait des jeux de cartes et de dés. Je vis des fermiers de village se réunir en clubs pour délibérer sur des intérêts de politique ou d'agriculture, et s'associer pour acheter des livres utiles, au nombre desquels ils mettaient l'Encyclopédie britannique, que l'on sait être rédigée, a Edimbourg, par des savans et des philosophes du premier ordre. Je vis enfin des classes supérieures de la société, assorties à ce haut degré de civilisation, et réellement dignes d'y occuper la première place par leurs lumières et par la noblesse de leurs sentimens; je les vis excitant, dirigeant toutes les entreprises d'utilité publique, communiquans sans cesse avec le peuple, et ne se confondant jamais avec lui; s'attachant à développer son intelligence pour l'éclairer sur ses devoirs et sur ses intérêts véritables; sachant le soulager dans ses besoins, sans lui ôter les vertus et l'indépendance que donne le soin d'y pourvoir; attirant ainsi par-tout ses regards sans exciter son envie; et, pour prix de tant d'efforts, la paix, l'union, l'estime reciproque, la confiance mutuelle, et même une affection très vive, fondée d'une part sur l'habitude de la bonté et la douceur des relations intimes, de l'autre sur la reconnaissance et le respect.

En quittant l'Ecosse, je visitai les contrées les plus industrieuses de l'industrieuse Angleterre. J'observai alors un

autre spectacle : je vis les forces de la nature, employées sous toutes les formes imaginables au service de l'homme, et celui-ci, réservé comme une mécanique plus chère et d'une construction plus délicate, pour les seules opérations intermittentes ou accidentelles que sa raison divine le rend plus propre à exécuter. Et, soit que les considérations de morale sociale qui m'avaient tant frappé eussent laissé des traces trop profondes dans mon ame ; soit qu'un grand système manufacturier doive plutôt être apprécié dans ses résultats nationaux que dans son influence locale et particulière, j'admirai cet immense développement des manufactures plus que je ne le souhaitai pour ma patrie. Après avoir salué Oxford et Cambridge, ces antiques et tranquilles séjours des lettres et des sciences, je vins rejoindre M. Arago à Londres, et m'associer encore avec lui pour la mesure du pendule à secondes, non plus toutefois dans une petite île presque déserte, mais dans le magnifique observatoire de Greenwich. M. de Humboldt, qui l'avait accompagné, prit part à cette opération, et voulut bien, pendant qu'elle dura, oublier la multitude de ses autres talens pour n'être qu'un excellent observateur. L'astronome royal, M. Pond, se plut à nous offrir toutes les facilités imaginables avec cet empressement généreux que les hommes vraiment dévoués aux sciences ont toujours, mais peuvent seuls avoir pour tout ce qui contribue à leur progrès. Apres avoir joui du plaisir d'observer le ciel et d'étudier un des plus grandes phénoménes de la nature avec de beaux instrumens, déja consacrés, pour ainsi dire, par tant d'observations, et dans un lieu renommé par tant de découvertes astronomiques, je revis enfin ma patrie avec ce bonheur du retour qu'éprouvent si vivement les cœurs français, et dont le charme était rendu plus doux encore par le sentiment intérieur de satisfaction et de reconnaissance dont je lui rapportais l'hommage. C'est en effet, dans un voyage entrepris pour l'avancement des sciences, qu'un Français peut apprendre à honorer davantage, et mieux chérir sa noble patrie. Placé hors du cercle des passions politiques, n'étant point attiré par l'intérêt ou l'ambition ; sans rang, sans richesses qui le soutiennent, il n'a pour lui que les titres que sa patrie

s'est acquis à la solide gloire, à celle qui fait du bien aux hommes. Il est porté par le souvenir de tant de services qu'elle a rendus à la civilisation du monde; par l'admiration universelle qu'ont excitée tant de chefs-d'œuvre dont elle a rempli les lettres, les sciences et les arts. Semblable à Minerve, cette patrie l'accompagne sur le sol étranger : elle parle pour lui, l'introduit, le protège, lui ouvre les cœurs, et réclame en sa faveur une hospitalité qu'elle-même a tant de fois et toujours si noblement accordée. Aussi, lorsqu'après avoir atteint le but de ses travaux, il raconte à ses compatriotes tout ce qu'il reçut d'accueil, de secours, de bienveillance, d'amitié même, chez une nation justement célèbre, il éprouve une jouissance d'autant plus pure à manifester l'expression de sa reconnaissance, que toutes ces faveurs sont encore, à ses yeux, de nouveaux dons de sa patrie.

Note. Ce que j'ai dit dans cette notice sur les vertus sociales de l'Ecosse et des îles Shetland, présente ces contrées sous un aspect si différent de nos habitudes continentales, que je ne serais pas surpris qu'en France, en Angleterre même, beaucoup de personnes supposassent qu'il y a quelque exagération dans cette peinture, et que j'ai involontairement cédé à la prédilection qu'un étranger prend toujours pour un pays nouveau où il est reçu avec bienveillance. Je puis cependant assurer que je n'ai été que vrai. On me croira peut être encore pour l'Ecosse; mais pour les îles Shetland, où trouverai-je des témoins? Quoiqu'elles soient peu distantes, la difficulté de la navigation, l'inclémence du climat et le défaut de commerce en éloignent les voyageurs; et ceux que, par intervalles, la nécessité y amène, se hâtent de partir dès que leurs affaires sont terminées. Peut être un séjour de deux mois, dans une position libre et désintéressée, m'a-t-il permis de voir ces îles plus intimement que ne l'ont fait la plupart des Ecossais qui les avoisinent. Aussi s'en fait-on de bien fausses ideés à Edimbourg même. Mais, en général, c'est un plaisir que l'on peut se procurer d'un bout de l'Europe à l'autre, que d'entendre chacun médire de ses voisins du nord. En Italie, on regarde la France comme un climat rude et sévère; voyez ce qu'en dit Alfieri. Ici, nous trouvons notre pays fort beau; mais l'Angleterre nous semble le séjour des brouillards. A Londres, on ne se plaint nullement du climat; mais on parle de l'Ecosse comme d'une contrée presque privée du soleil. Les Ecossais trouvent cette opinion fort ridicule; mais ils ont en grande pitié les pauvres Shetlandais. Ceux-ci, à leur tour, prétendent qu'ils ont beaucoup moins froid qu'en Ecosse, mais qu'on est bien malheureux en Islande et aux îles Feroé. Je suis persuadé, que les Islandais même ont encore quelque dédain pour le Spitzberg. La vérité est que, dans tous les climats

du monde, l'homme peut vivre avec une somme de bonheur à-peu-près égale, s'il y porte avec lui les vertus sociales et les ressources du commerce et de la civilisation.

In reverting to the scientific object of M. Biot's visit to our sea-girt shores, we have the satisfaction of informing our readers, that in pursuance of the recommendation of the President and Council of the Royal Society, Captain Kater has undertaken a journey to the North, with a view of ascertaining the length of the Seconds Pendulum at the principal stations of Colonel Mudge's Trigonometrical Survey, and that the Government has afforded ready and liberal assistance towards this important investigation.

Art. XX. *Proceedings of the Royal Society of London.*

Thursday, April 9. A Paper was transmitted from the Society for improving Animal Chemistry, containing an account of the Urinary Organs and Secretions of some Amphibious Animals, by Dr. John Davy.

In this paper, the urinary organs of some species of serpents and lizards, and of the turtle and tortoise, are described. The white matter voided by snakes is almost entirely pure uric acid, and the same substance was discovered in the urine of the other animals mentioned.

A Paper was also communicated by A. Cooper, Esq. on an improved method of making Anatomical Preparations, by Mr. Joseph Swan.

Corrosive sublimate is the preservative here recommended.

April 16. A Paper on malconformation of the Uterus was read, by Dr. Granville.

April 30. A Paper was read, entitled new experimental researches on some of the leading doctrines of Caloric, particularly on the relation between the elasticity, temperature, and latent heat of different vapours, and on thermometric admeasurement and capacity, by Dr. Ure. This paper contained a variety of important and apparently accurate investigations, upon the above

important questions, and may be considered as a valuable addition to our stock of theoretical and practical knowledge, in a very interesting department of science.

May 7. A Letter was read from Mr. Greatorex, containing an account of a geometrical admeasurement of Skiddaw, whence it appeared that the height of that mountain is 1012 yards 3½ inches.

A Letter addressed by B. Bevan, Esq. to the President, was also read, containing the results of a registering rain gauge, for the year 1817. The average time of actual rain was 1 hour 47 minutes per day. The average quantity per day was 0,68 inches. The observations were made at Leighton in Bedfordshire.

A Paper was also read, on the Structure of the poisonous fangs of serpents, by Thomas Smith, Esq. F. R. S.

The author shows that there is a longitudinal fissure in the poison teeth of serpents, the use of which is not quite apparent. In the teeth of harmless serpents, no such formation is perceptible.

May 21. A Paper on the different modes of constructing a catalogue of fixed stars, by John Pond, Esq. Astronomer Royal, was read.

Mr. Pond here proposed a method of effecting the above purpose, by which in a single year, the same accuracy is attained as was formerly derived from the observations of three years.

A Paper was also communicated from Lieutenant Colonel William Lambton, entitled "An abstract of the results deduced from the measurement of an arc of the meridian, extending from latitude 8° 9′ 38″,4 to latitude 18° 3′ 23″,6 N. being an amplitude of 9° 53′ 45″,2."

May 28. The Astronomer Royal read a Paper on the Parallax of the fixed stars in right ascension.

At the same Meeting, a Paper was read, on the oxides and salts of mercury, by Mr. Donovan.

June 4. A description of the teeth of the Delphinus Gangeticus, was presented to the Society by Sir Everard Home, Bart. V. P. R. S. And at the same Meeting, Dr. Granville gave an account of the production of sulphuretted azote in the abdomen, resulting from the decomposition of an albuminous

dropsical fluid. The Doctor considers this as a new and definite gaseous compound, and the results of his experiments led him to consider its component parts as

89,60 azote.
10,40 sulphur.

A Paper was also read by John Williams, Esq. describing the influence of galvanism upon the germination of seeds, which when powerful enough to do any thing, appeared generally injurious.

June 11. Dr. Prout communicated a Paper, describing a new acid principle, prepared from the lithic or uric acid.

Our readers are well aware of the characteristic property of uric acid of producing a fine red compound, when heated with nitric acid.

Dr. Prout shows, by some very interesting experiments, that this is a compound of a new acid principle with ammonia. This acid forms purple or red compounds, with the metallic oxides, whence he calls it the *purpuric acid.*

A communication was also received from Sir W. Herschel, consisting of astronomical observations and experiments, selected for the purpose of ascertaining the relative distances of clusters of stars, and of investigating how far the power of our telescopes may be expected to reach into space, when directed to ambiguous celestial objects.

The President then adjourned the Society for the long vacation, which terminates on the 5th of November.

Art. XXI. *Miscellanea.*

I. Mechanical Science.

§ 1. Mathematics, Astronomy, &c.

1. *Mathematical Prize Question for* 1820.

The Royal Academy of Sciences at Paris, have again proposed as a question for 1820, the following theorem of Fermat. "Beyond the second degree, there exists no power which may be divided into two other powers of the same degree." The

reward is a gold medal of 3000 francs value, and the latest time allowed for the reception of memoirs, 1st January, 1820.

2. *Astronomical Prize Question for* 1820.

The question proposed by the Royal Academy of Science at Paris, is as follows: — To form by the theory of universal gravitation alone, and without taking from observations, any thing but arbitrary elements, tables of the movement of the moon, as exact as the best tables in existence. The prize is a gold medal of 3000 francs value, which is to be awarded in March 1820. The utmost period allowed for the reception of papers, 1st January, 1820.

3. *Astronomical Prize Medal.*

The Royal Academy of Sciences at Paris, have awarded their own gold medal to the astronomer Royal, John Pond, Esq. That which was before voted to him was the one founded by the astronomer De Lalande.

4. *Harvest Moons.*

This year is the third of a series of 10 years in which the moon will prove the most beneficial to the farmers for reaping and gathering in the fruits of the earth, *viz.* from 1816 to 1825 inclusive. The preceding nine years, namely, from 1807 to 1815 inclusive, were in the class of those in which, from natural causes, the harvest moon has been least beneficial. Such will also be the years from 1826 to 1882.

§ 2. Architecture, the Arts, Agriculture, &c.

1. *Incombustible Store-House at Plymouth.*

The incombustible Store-House which has just been completed in Plymouth Dock-Yard, has every part of it composed either of stone or iron. The girdlers, joists, doors, sashes, and frames, are all of cast iron, neatly executed. The roof is of cast iron, and the floors of Yorkshire stone. The stair-case, which is a geometrical one, is of moorstone. The estimated expense of the building is fifteen thousand pounds.

2. *Mr.* Feetham's *Description of an Apparatus for sweeping Chimneys, without the aid of Climbing Boys.*

In consequence of the repeated occasions on which I

have examined chimneys, my attention has been strongly drawn to the various methods of sweeping them, and as I found that none of the mechanical contrivances answered completely the desired end, and that cases frequently occurred when they were entirely inadequate, I was induced to contrive a machine for my own use. As this machine has for the last six or seven years completely answered my wishes, and as it has been approved of by many eminent surveyors and builders, I shall no longer hesitate to make it public.

The apparatus consists of a thin iron box or frame, about 13 inches by 11, with two closely fitted doors, 4 inches apart, forming the back and front; a pulley is fixed to the lower part of the frame, in either an inclined or vertical direction, according to the inclination of the flue. This frame is fitted into the chimney as near the top as is convenient, either in the attic, loft, or on the roof, so that the door may be got at with ease. From this door upwards, the chimney is cleaned by an elastic whalebone brush, and downwards in the following manner: a whalebone brush, which may be shaped to any sized flue by the person who is using it, has a ball of iron fixed to the lower part of it in gimballs, so that it can roll in any direction downwards, and a rope is made fast to the upper end; the brush and ball are put through the door into the chimney, and the rope placed over the pulley; the weight carries the brush down, and it is drawn up again by the line, so that it can be made to traverse three or four times up and down the chimney in a few minutes; the door is shut during this operation, the rope passing through a small notch in it, so that scarcely any dirt is occasioned. The brush will pass down a flue that has a considerable degree of inclination, but at horizontal parts, or at square angles, extra doors will be required. These, however, by the advantages they afford, will abundantly compensate the slight additional expense; they afford the readiest means of extinguishing fires, of stopping descending currents of smoke from neighbouring flues, or of working in any way in the chimney: and

they would generally be on the outside of the house, because horizontal flues are mostly in those situations.

In the chimneys of my house, No. 9, Ludgate Hill, the flues are very high, and some of them much inclined. No sweep has been up them for seven years. The jointed-handle brush was tried in vain; it required too much force, and was liable to break; but by the apparatus described they have always been readily and perfectly swept in a few minutes. The whole expense of the apparatus made in the best manner, does not exceed £1..5. and without any particular attention, does not require repairs, or replacing in a long period of time. They may be examined and seen in use at the Inventor's Warerooms and Manufactories, 9 Ludgate Hill, or 296 Oxford Street.

3. *Telegraphs.*

Intelligence can be received from Calais at Paris, between which places there are twenty-seven telegraphs, in three minutes; from Lisle, twenty-two telegraphs, two minutes; from Strasburg, forty-five telegraphs, six minutes and-a-half; from Lyons, fifty telegraphs, nine minutes; and from Brest thirty telegraphs, eight minutes.

4. *Roller Pump.*

A roller pump on an improved principle has recently been erected near Worcester, for raising water from the Severn into the basin of the canal, where it throws up at least 900 gallons per minute. It works by a rotatory motion, without bucket or rod, and produces a constant stream. It is entirely made of metal.

5. *Propagation of Olive Trees.*

It has long been an object in the south of France and in other olive countries to propagate the olive-tree by seeds; but attempts of this kind have constantly failed; and shoots were found the only mode of increasing their number that could be artificially used. A mode, however, has been discovered, which has set aside the difficulty; it consists in macerating the ripe olives in a weak alkaline solution, and then sowing them, the seeds will germinate, and produce plants.

The discovery resulted from an observation of the manner in

which nature propagates those trees: the seeds germinate naturally, and this was supposed to be occasioned by the previous effect produced on them, in passing through the stomach of birds, and it was found on trials that the seeds of the fruit given to turkeys when sown with the dung of the animal did vegetate.

6. *Blight in Apple-trees.*

The American farmers are said to adopt the following practice to prevent the blight or mildew from injuring their orchards. In the spring, they rub tar well into the bark of the apple-trees about four or six inches wide round each tree and at about one foot from the ground; this effectually prevents the blight, and abundant crops are the consequence.

7. *Fly in Turnips.*

The following has been given as a method of preventing destruction by the *fly* in turnips. Divide the seed intended for one day's sowing into two equal parts, and put one part to steep in soft pond or ditch-water the night previous to its being used. Mix the whole together, adding to each pound of seed, two ounces of flour sulphur. This will insure two successive growths, and the fly will not touch the plants.

8. *Sugar of the Beet-root.*

The endeavours that were made in France, during the war, to procure sugar from the beet-root in sufficient quantity to satisfy the demands of the population, were very successful, and it was procured of excellent quality. The peace, however, by re-opening the ports, and allowing the introduction of the cane-sugar, tended to paralyze that branch of agricultural industry, for which, however, some strong exertions have since been made by the philosophers of France.

The following is given as the statement of the expense and returns of the manufactory of M. Chaptal, and if there are no unstated objections to its introduction, it is difficult to account for the preference given to cane-sugar.

Forty-five French acres were sown with beet-root; the produce equalled 700,000lbs.

Charges.	*francs*
Sowing, pulling, carriage, and expenses of the manufactory for seventy-nine days of actual work -	7000
Workmen - - - -	2075
Fuel - - - - - - -	4500
Animal Charcoal - - -	1100
Repairs, interest of capital, &c. - -	4000
francs	18675

Produce.	*lbs.*
Rough sugar of the first crystallisation -	29,132
Sugar obtained by further processes from the molasses	10,960
Total of rough sugar	40,092

Besides which there were 158,000lbs. of refuse, which was excellent food for cattle, and a large quantity of exhausted molasses, which might be converted into spirit.

II. Chemical Science.

§ 1. Chemistry.

1. *A Letter to Mr. Brande on the Subject of the Pharmacopœia, from Thomas Young, M.D. F.R.S. Fellow of the Royal College of Physicians; with Mr. Brande's Answer.*

Dear Sir,

I am sorry to observe, in your Introductory Discourse to the third volume of the Supplement to the Encyclopædia, a note containing a very severe censure on the College of Physicians of London, whose Pharmacopœia, you say, " is a record of the want of chemical knowledge where it is more imperiously required." But I am really willing to hope, that on reconsideration, you will allow that the charge was hasty, and unwarranted by the present state of the Pharmacopœia.

Much has been said, by several persons attached to chemistry, of the errors and imperfections of the Pharmacopœia of 1809; and having been appointed by the President an additional Member of the Committee for revising it, I made it my particular study to examine every single objection that had

been advanced, and in concert with my colleagues, to take measures for adopting every necessary correction that had been suggested: but, in justice to the original members of the Committee, I cannot hesitate to declare, that, even granting the truth of all the chemical facts adduced by their opponents, the Work exhibited nothing like those gross errors which a too captious severity of criticism had repeatedly attributed to it, and that almost every one of the charges, relating to the chemical department, have been absurdly and ridiculously exaggerated.

But whatever these errors may have been, I am at a loss to understand to which of them your remark can at present be supposed to apply, when two re-impressions of the work have appeared, in which, with the assistance derived from the experiments of a practical chemist obligingly recommended by yourself, all possible care has been taken to make every correction that candour could allow to be requisite. I therefore feel myself personally bound to call on you for such an explanation of your censure, as will enable me to answer your objections in detail; and I will venture to pledge myself to prove, that the College of Physicians has *not* recorded its deficiency in any of those points which are "imperiously required" for the due performance of all the practical duties of the profession.

I am, dear Sir, your faithful and obedient Servant,

Welbeck Street, June 11, 1818. THOMAS YOUNG.

To Dr. Thomas Young.

My dear Sir,

The remark in my dissertation, refers exclusively to the London Pharmacopœia for 1809; the errors of which I cannot by any means consider as cancelled by the subsequent *re-impressions*, as you most charitably call them. I am sorry, therefore, that I cannot honourably recant; and regret that the Committee did not contrive to avail itself of your services previous to the publication, instead of merely appointing you an "additional member," when the mischief was done.

This is perhaps sufficient explanation of my censure. Should more substantial grounds be required, I refer to Mr. Richard Phillips's experimental examination of the Pharmacopœia for

1809: in the *facts* there disclosed, you cannot fail to discern them.

The evident carelessness of the College, as a body, was uppermost in my mind when I wrote the offending paragraph; and the very circumstance of the list of FELLOWS being adorned with the names of men highly eminent in chemical science, renders that carelessness more unaccountable, and may well be urged in justification of my remark. I hope, therefore, that on the whole, my inclination was rather to *extenuate, than set down aught in malice*; to adduce nothing that was false, rather, than all that was true; and experience one only source of regret, that of having occasioned any unfriendly feeling in one for whom I have such unfeigned respect and regard as yourself.

I am, dear Sir, your faithful and obedient Servant,

Albemarle Street, June 12, 1818. W. T. BRANDE.

2. *Reduction of Chloride of Silver by Hydrogen.*

The following method of reducing chloride of silver, is perhaps not sufficiently known. It was communicated by M. Arfwedson. Liberate hydrogen in contact with chloride of silver, as by mixing the chloride, zinc, sulphuric acid, and water together, and the silver will be reduced to the metallic state; the zinc is easily dissolved out by excess of acid, and the metal obtained by filtration or decantation.

3. *Prize Question of the Academy of Sciences at Paris for* 1819.

The Royal Academy of Sciences at Paris give as the subject for the prize essay to be decided March, 1819—"To determine the chemical changes which take place in fruits during and after their ripening.

"For the solution of this question, the influence of the atmosphere which surrounds the fruit, and the change it suffers, ought to be examined with attention.

"The observations may be confined to a few fruits of different kinds, provided that general consequences can be drawn from them."

The reward is a gold medal 3000 francs in value, and the latest period at which any memoir can be received will be 1st. January 1819.

The subject of a second reward is as follows:—

"1st. To determine by direct and accurate experiments, all the effects of the *diffraction* of rays of light, either direct or reflected, when they pass separately or together near the extremity of one or many bodies of an extent either limited or indefinite, having regard to the intervals of those bodies as well as to the distance of the luminous focus from whence the rays emanate.

"2d. To conclude from those experiments by mathematical induction the motion of rays in their passage near to bodies."

The reward is a gold medal of the value of 3000 francs.

As the meetings close on the 1st of August 1818, the memoirs should be remitted to the secretary of the Institute before that time, that the experiments made, may be verified.

4. *Gottingen Chemical Prize for* 1819.

The Royal Society of Gottingen has offered a prize of fifty ducats for "An accurate examination founded on precise experiments of Dalton's theory of the expansion of liquids and elastic fluids, especially of mercury and atmospheric air by heat."

The authors are to pay attention to the necessity alleged by Dalton for changing the progression of the degrees of the present thermometrical scales. The memoirs must be transmitted to the Society before the end of September, 1819.*

5. *Boiling point of Fluids.*

M. Gay Lussac has in a late Number of the Annales de Chimie, shewn that the boiling point of water and other liquids varies independently of atmospheric pressure. The circumstances which influence it appearing to be the nature of the body which is in contact with the boiling fluid, the cohesion of the fluid, and the resistance which is opposed to a change of state, as in the cases of every other equilibrium of forces.

Water boiled in a glass vessel rises to a temperature of more

* This question has been discussed in a Paper lately read to the Royal Society, by Dr. Ure.

than one degree of the centegrade thermometer higher than when boiled in a metallic vessel; and the effect appears to be due to the nature of the surface in contact with the fluid; this is rendered evident by placing a metallic surface in contact with water boiled in a glass vessel. If a flask of water be placed over a lamp until its temperature be raised to the point of ebullition, and it be noticed, and then a portion of iron filings thrown in, the temperature will fall, and the boiling will go on, as in a metallic vessel.

It is to be observed that this effect of difference of temperature appears to be not so much a constant and specific effect as the apparent result of other circumstances. Water boiled in a glass vessel and open to the air, is continually changing its temperature, sometimes rising and sometimes falling within a certain minute range, and these changes accord with the evolution of vapour from the fluid. Either water or alcohol, when boiled in glass vessels, do not generally give off vapour in a regular uniform way, but whole torrents rise at once from the under surface with great force, producing a kind of explosion; the fluid is then quiet for a moment, and then another gust of vapour rises up. Now, during the time the vapour rises the temperature falls, and whilst the fluid is quiet the heat rises, so that it is continually changing; and as the lowest point is the true boiling point, it is evident that the mean temperature of water boiled in a glass vessel must be above that point. In a metallic vessel, on the contrary, as soon as the water or fluid has attained the boiling point, the conversion into vapour commences, and if the heat is continued, the steam is constantly and regularly generated and given off.

M. Gay Lussac seems inclined to account for the effect in glass vessels by the cohesion of the fluid to the surface of the vessel. It is evident that when vapour is formed in the interior of a liquid body, one force to be overcome is the cohesion of the particles of the liquid; this force will of course be constant for the same liquid in vessels of every material. An analogous force is that exerted between the liquid and the substance of the vessel, and this will vary with the substance; and as the vapour is generated at the point of contact be-

tween the fluid and the vessel, the variation of this force will vary the temperature at which vapour will be formed.

M. Gay Lussac also gives, as another power which has influence in these phenomena, the resistance to a change of state; but observes, that it is difficult to analyze and describe; and he concludes in this part, that the conducting power for heat, and the nature of the surface, appear to exert an influence on the boiling point of water; and that every thing else being equal, water boils more readily on a metallic surface than on a glass surface, and more readily in a glass vessel containing glass in powder, than in a glass vessel containing nothing but the fluid.

The application which M. Gay Lussac proposes to make of the property which metals have of inducing ebullition before glass or earthen ware vessels, is to prevent those sort of explosions which take place in distillations. If into a retort, or flask, containing alcohol, water, or particularly sulphuric acid, some little pieces of platinum wire be put, the concussions, which are so violent as sometimes to break the vessels, will be prevented, and the vapour formed and liberated in a regular manner. This mode has been adopted for some years in this country by the makers of vitriol, where glass vessels are used to distil in. Where the retort is made of platinum, it is obviously unnecessary.

M. Gay Lussac observes, that an important consideration in the graduation of thermometers arises from the above facts, and that the variation pointed out ought to be guarded against, as a source of error.

6. *Oxide of Lead crystallized.*

Mr. Houtan Labillardiere has described a crystallization of the oxide of lead from its solution in soda. The solution had been left to itself during the winter, and had deposited many small crystals of a regular dodecahedral form, white, and semi-transparent. They were insoluble in water; on burning charcoal, were reduced to lead; and were not diminished in weight when heated in a platinum crucible. They dissolved without effervescence in nitric acid, the solution was not rendered

turbid by the nitrates of silver or barytes, but threw down a black precipitate with the hydrosulphuret of potash, and a white one with sulphuric acid, which was insoluble in nitric acid. These results prove the crystals to be pure oxide of lead.

7. *Crystallized Iodine.*

Some curious observations on the forms of crystallized iodine have been published in the Bibliothèque Universelle. Crystals had formed on the surface and at the bottom of a solution of iodine, by slow evaporation, and were all of them cubes. In another solution they had formed in great abundance on the surface, and in the upper part of the bottles; and with the exception of a single crystal, which was rhomboidal, were perfect cubes; some of them were as much as half a line in the side. The crystals increased rapidly in size, although the temperature of the place was never above 45°,5 of Fahrenheit, and was frequently at the freezing point of water.

In the distillation of iodine from water, very fine crystals were obtained, but of a different form. The apparatus was a retort, an adapter, and a globe. The adapter was preserved at a low temperature, and soon became lined with crystals resembling fern leaves. Each leaf appeared to be attached to the glass by a sort of stalk, and they affected a parallelism with the axis of the adapter. Some of them were nearly an inch in length, diminishing gradually in width towards the end.

8. *Radiant Heat.*

MM. Dulong and Petit have lately given to the world a Memoir on Heat, which gained the prize medal for 1818, of the Academy of Sciences.

The Paper is of considerable length. It contains researches of the most elaborate kind, and extreme accuracy appears to have been attained in every thing connected with them.

The title of the Paper is "*On the Measure of Temperatures, and on the Laws of the Communication of Heat.*" Every part of the detail is of such interest, that an abridgement would hardly obtain justification, and the following translation of the conclusion, is only given as a condensed table of that which the body of the Paper contains.

" In distinguishing, as we have done, the losses of heat due to the contact of fluids and to radiation separately, it will be observed, that each of those effects is subject to particular laws. These laws should express the relations between the temperature of the body and the velocity of its cooling in all circumstances; and it must be remembered, that by velocity of cooling *(vitesse de refroidissement)* we constantly mean the number of degrees which the temperature of a body falls during a constant but infinitely minute portion of time.

Law 1. If the cooling of a body placed in a vacuum terminated by a medium absolutely deprived of heat, or of the power of radiating, could be observed, the velocity of cooling would decrease in a geometrical progression, whilst the temperature diminished in an arithmetical progression.

2. For the same temperature of the boundary of the vacuum in which a body is placed, the velocity of cooling for the excess of temperature in arithmetical progression, will decrease, as the terms of a geometrical progression diminished by a constant number. The ratio of this geometrical progression is the same for all bodies, and equal to 1.0077.

3. The velocity of cooling in a vacuum for the same excess of temperature increases in a geometrical progression, the temperature of the surrounding body increasing in an arithmetical progression. The ratio of the progression is also 1.0077 for all bodies.

4. The velocity of cooling due to the contact of a gas is entirely independent of the nature of the surface of bodies.

5. The velocity of cooling due to the contact of a fluid (gas), varies in a geometrical progression, the excess of temperature varying also in a geometrical temperature. If the ratio of the last progression be 2, that of the first is 2.35; whatever the nature of the gas, or whatever its force of elasticity. This law may also be expressed, by saying, that the quantity of heat abstracted by a gas, is in all cases proportionate to the excess of the temperature of the body raised to the power of 1.233.

6. The cooling power of a fluid (gas) diminishes in a geometrical progression, when its tension or elasticity diminishes

also in a geometrical progression. If the ratio of this second progression be 2, the ratio of the first will be for air 1.366; for hydrogen 1.301; for carbonic acid 1.431; for olefiant gas 1.415. This law may be expressed in the following manner:—

The cooling power of a gas is, other things being equal, proportionate to a certain power of the pressure. The exponent of this power, which depends on the nature of the gas, is for air 0.45; for hydrogen 0.315;* for carbonic acid 0.517; for olefiant gas 0.501.

7. The cooling power of a gas varies with its temperature; so that if the gas can dilate so as to preserve the same degree of elasticity, the cooling power will be found diminished by the rarefaction of the gas, just as much as it is increased by its being heated, so that ultimately it depends upon its tension alone.

It may be perceived from the above propositions, that the law of cooling, composed of all the preceding laws, must be very complicated; it is not therefore given in common language but may be found in a mathematical form in the body of the memoir.

9. *On a Mode of preserving some Vegetable Remedies. By Marshall Hall, M. D.*

It is an object of much regret, that all the modes of preparing vegetable remedies hitherto employed are defective, and that no mode of preserving these substances with their virtues unimpaired, should have been discovered. Sometimes the process of preparation injures the virtues of the remedy, or extracts them partially only; in other cases, their subsequent preservation is imperfect. Dried vegetable remedies, extracts, tinctures, infusions, and decoctions, are all liable to one or more of these objections.

Might not some of the vegetable remedies be preserved without subjecting them to any previous process, or to the action of any external agent, by which their virtues are partially destroyed, or only partially extracted? In the case of digitalis, cienta, hyoscyamus, &c. the writer has taken the fresh herb, collected

* It is given as 0.38 in the Mémoire.

free from dew, and having rubbed the leaves, into the finest pulp, he has simply formed a properly consistent mass, by the addition and careful intermixture of *white sugar*, or of *dried soap*. In this manner the vegetable may be long preserved; and the advantages are obtained of administering it throughout the year in its pristine state, and without previously subjecting it to any operation, or to the agency of any substance by which its properties might be enfeebled or destroyed. It must remain to be decided which of the two modes is the preferable one, and whether each may not be better adapted than the other, for the preservation of particular substances. Either compound may be formed into pills, or mechanically suspended in a draught or mixture.

10. *On the spontaneous Combustion of Cotton Goods, which have been imbued with Linseed Oil. By Marshall Hall, M. D.*

It is well known that cotton goods, either intentionally, or accidentally, imbued with linseed oil, are liable to take fire spontaneously.* Two instances of the latter accident have occurred within the writer's knowledge, by which the danger of dreadful fires was incurred. Many fires in cotton mills are probably owing to this accident; and this reflection should suggest a particular caution on the part of the owners and insurers of these manufactories.

It has also occurred to the writer, to see the spontaneous inflammution of the oiled cotton itself, and to examine the heap of oiled cotton before and after the combustion had begun and had been arrested. The centre of this heap, even when far from the state of combustion, was many degrees higher than that of the surrounding atmosphere.

The rationale of this phenomenon appears to be the following; the oil absorbs the oxygen from the contiguous atmosphere. This may be readily seen by enclosing a portion of cotton moistened with linseed oil in an inverted glass jar; the enclosed gas is in the course of a short time diminished in bulk and deprived

* See Nicholson's Journal, vol. 21, p. 44.

of its oxygen. In large heaps, a degree of increased temperature is induced by the consolidation of the oxygen gas. This in time augments, so as to induce that species of combustion, which consists in the propagation of sparks, but is unattended with flame. At length complete inflammation is induced.

The transition from the slow combination of oxygen, to the state of combustion without flame, and from this latter to inflammation, is worthy of the particular attention of chemists.

11. *On the Moiré Metallique, or Fer blanc moiré.*

This is an article of Parisian manufacture, much employed to cover ornamental cabinet work, dressing boxes, telescopes, opera glasses, &c. &c. and is prepared in the following manner.

Sulphuric acid is to be diluted with seven or nine parts of water, then dip a sponge or rag into it, and wash with it the surface of a sheet of tin, which speedily will exhibit an appearance of crystallization, which is the Moiré.*

This effect however cannot be easily produced upon every sort of sheet tin, for if the sheet has been much hardened by hammering or rolling, then the moiré cannot be effected until the sheet of tin has heen heated so as to produce an incipient fusion on the surface, after which the acid will act upon it and produce the moiré. Almost any acid will do as well as the sulphuric, and it is said that the citric acid dissolved in a sufficient quantity of water, answers better than any other.

The moiré has of late been much improved by employing the blow pipe, to form small and beautiful specks on the surface of the tin, previous to the application of acid.

When the moiré has been formed, the plate is to be varnished and polished, the varnish being tinted with any glazing colour, and thus the red, blue, green, yellow, and pearl coloured moirés are manufactured.

12. *Reduction of the Oxide of Silver by Ammonia.*

A strong solution of ammonia saturated with oxide of silver,

* The word Moiré signifies *watered*, as La Soie Moirée, watered silk.

and then filtered, was put away in a closely stopped bottle for between three and four months. At the end of that time being examined, the bottle was found lined with a brilliant coat of metallic silver. The stopper had become fixed in the bottle, but on tapping it with a piece of wood, the neck of the bottle flew off with great force, being propelled by the expansion of a very condensed atmosphere within. A burning taper being introduced into the bottle (which had been about two-thirds filled with the solution) was extinguished. The solution poured out was found still to contain much silver, in the state of oxide. The crust of silver on the exterior of the bottle was spongy and porous in its texture, but having a brilliant compact surface in contact with the glass towards the lower part of the bottle; it was the thirtieth of an inch in thickness. An irregular mass of silver had formed in the bottom of the bottle, which when taken out presented an exact cast of the glass. No oxide of silver had been deposited nor was any fulminating compound formed. From the quantity of chloride yielded by the oxide remaining dissolved in the ammonia, about two-thirds of the whole quantity must have been reduced in this way by the decomposition of the ammonia.

M. F.

13. *Chinese mode of making Sheet Lead.*

Two large tiles perfectly flat, are covered on one side, each with very thick paper; they are then placed horizontally with the paper surfaces together. The workman lifting up one angle of the uppermost plane, introduces a sufficient quantity of melted lead to make a sheet, and immediately lowering the tile, jumps upon it, and presses it strongly with his feet; the metal is thus extended into an irregular sheet.

To prevent the oxydation of the lead, they employ a kind of resin called *dummer*.

14. *Ignited Platinum Wire.*

In the last Number of the Journal it was mentioned, that Sir Humphry Davy's experiment of the glowing platinum wire could be made when the combustible used was camphor. This substance, from its portability, &c. is perhaps the best calculated

of any known to shew the experimeut. If a piece of camphor, or a few small fragments in a heap, be placed in any convenient situation, as on a shilling, the bottom of a glass, &c. and a piece of platinum wire, either coiled or pressed up together, be heated and laid upon it, the platina will glow brilliantly as long as any camphor remains, and will frequently light it up into a flame.

15. *Explosion from Fire-damp.*

A dreadful explosion took place in the coal mines of Warnes, near Mons, on the 9th of April, by which between thirty and forty of the workmen were killed and wounded. Sir H. Davy in passing through Flanders, found many very bad lamps in use, but no accidents had happened in these mines. Perfect models were left with them, which they gladly promised to imitate exactly.

16. *New Products from Coal.*

It is said that Dr. Jassmeyer, Professor of Chemistry in Vienna, has made the discovery of a means to extract from coals two hitherto unknown acids, a resin, a resinous gum, and other products, which he has employed with success in the dying of wool, silk, hair, and linen; and that he has produced from them red, black, yellow, and various shades of brown and grey. The President of the Aulic Chamber, and other enlightened judges of these matters, have given their approbation to the discovery.

17. *New Metal.*

M. Stromeyer has discovered the existence of a new metal in the ores of zinc; he calls it *cadmium*. It looks like tin, and its chemical habitudes much resemble zinc, but it is precipitated from its solutions in the metallic state by the latter metal.

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§ II. Meteorology.

1. *Rain of Earthy Matter.*

M. Sementini, of Naples, has given an account, with an analysis, of a red rain, which fell in the kingdom of Naples and in Calabria, on 14th March, 1818. The weather at the time

was very stormy, with much thunder and lightning, and the sky dismally red. The people were much alarmed at seeing the red rain; some called it *blood*, others *fire*.

When the powder was collected and dried, it appeared of a yellow colour like canilla, unctuous to the touch, of an earthy taste, and a specific gravity of 2,07. It effervesced with acids; heated, it became brown, black, and lastly red. It contained,

Silex	- -	33
Alumine	- -	15.5
Lime	- -	11.5
Chrome	- -	1
Iron	- -	14.5
Carbonic acid	-	9
		84.5
Loss	- -	15.5

On examining the occasion of this loss, it was found to be a combustible substance soluble in alcohol, which when evaporated was adhesive, transparent, of a yellow colour, of an acrid resinous taste; and leaving, on combustion, a residuum of charcoal. Its weight nearly equalled the observed loss.

Specimens collected from different parts of the country differed in their proportions, but not in the principles. M. Sementini appears to think that this powder cannot have had a volcanic origin, and observes that the presence of chrome assimilates it with meteoric stones.

2. *Halo.*

A beautiful halo appeared round the moon on the evening of Tuesday, April 14th, of immense size; it was seen from half-past eight till twelve o'clock, and probably at a much later hour. It was about forty-four degrees in diameter, and appeared situated above the clouds, which now and then came before it. The evening was clear and serene, and the embodied vapours always diminished its splendour. On the next evening it was again visible, but its diameter was now nearly forty-nine degrees, and it appeared more broken. A similar halo was seen on the eighth of the same month; and it is probable, that the state of the upper regions of the atmosphere, which gave rise to

these phenomena, had been nearly permanent during the whole time which intervened between the observations.

3. *Meteoric Iron.*

There is a character first pointed out in Germany, belonging to meteoric iron, which is, perhaps, not very generally known. It consists in the production of regular figures and crystalline facets on the polished surface of the iron, when moistened with nitric acid, analogous to those produced in the moiré metallique. This character has been found to belong to all the well known specimens of meteoric iron that have been tried, and as distinctly in the grains found in meteoric stones, as in larger masses of the metal; but it has been looked for in vain in the native iron of Charlesdorf, of Veiben, of the hill of Briandi (de Chladni) of Peru, and in the mass at the Cape, first made known by Barrow and Dankelmann.

4. *Earthquake.*

A violent shock of an earthquake was felt at eighteen minutes after midnight, on the 7th of April, in the commune of Latour, in the province of Pignerol, and was followed by four others. The inhabitants left their houses. There were several shocks also on the 9th, but weaker than the former.

5. *Ice from the North.*

From the accounts brought to this country by various vessels, it appears that immense masses and quantities of ice are floating down from the North, as was the case during last spring and summer. A packet from Halifax saw one 200 yards in height and apparently seven leagues in circumference, standing southward with the current. Captain Quereau, of the Grand Turk, which arrived at Derry, from New York, states that on 15th of February, lat. 43° he passed several immense floating islands of ice, some miles in extent and from three to four hundred feet high. The ship, with strong westerly gales, was two days among them.

6. *Description of the Lake which has been formed in the Valley of Bagne, in the Valaise. May 19.*

This valley, situated five leagues beyond St. Branchier, is very

narrow at the entrance, being formed by the steep side of Mauvoisin on the south, and on the north by Mount Pleureur, which in its height exceeds even the former. The lower part of the latter presents a rocky surface above 500 feet in height, and this is capped by the immense glacier of Chedroz, which rises up to the summit of the mountain.

From this glacier enormous blocks of ice are precipitated almost daily, which falling into the valley, are accumulated by the rocks, where dissolving, they form cascades, which descend in all directions. The river Drance, which results from the waters of more distant glaciers, in passing through this valley, has formed for itself a bed under the mass of ice and snow thus accumulated, and is for some distance hidden from the day.

Within the last three years the magnitude of this subordinate glacier has very much increased, and during the last winter, the passage by which the river made its exist has been closed. The waters have, therefore, been retained within the valley, and now make an immense lake, confined on one side only by this wall of ice. This barrier extends directly across the valley, and has fixed itself against the two opposed mountains. Its length, at the upper part is about 500 feet, its width below at least 900 feet, and its height near the side of Mauvoisin, the lowest part, near 220 feet; on the opposite side it is considerably more.

On the 14th May the lake was 7200 feet in length, and 630 in width, its greatest depth 180 feet; but it continued to increase daily. On the 10th and 11th of May, it rose eight inches in twenty-four hours; and on the 12th and 13th, the increase was three feet in twenty-four hours. The difference, however, is partly due to the variable inclination of the sides of the valley, and the melting of the snows. The level of the lake is about 100 feet above the foot of the icy embankment.

The government of the canton of Valais, to prevent the ravages which would result from a sudden inundation, have set on foot such works as are practicable; they consist in the formation of a channel, or gallery cut through the ice, and the work was began at a height of about 50 feet above the level of the lake, that sufficient time might be gained to complete it

before the waters filled the works. It is expected, that if the barrier itself remains firm, the waters will, on gaining the opening, issue forth there, and gradually thawing the ice, will deepen this artificial river bed, and lower the lake.

In 1595, an inundation took place in this same valley, from an exactly similar cause. It destroyed the villages situated on the banks of the Drance, and carried away great part of the town of Martigany; but it is hoped, from the precautions taken, that a repetition of these misfortunes will not occur; and from the immense body of ice accumulated, no fears are entertained that the liberation of the waters will be sudden.

A calculation has been made, by order of the government of the canton of Vaud, of the effect that would be produced on the river Rhine, supposing the waters thus pent up to be let loose at once; and the result is, that that river would not rise more than four feet, if such an event should happen; therefore whilst the river is low, no harm would result to that Canton; if the waters were previously somewhat elevated, parts would be inundated. Various signals have been established on the elevated and important parts of the country, to give notice should a sudden rupture of the ice take place.

June 2. The waters of the lake still continue to increase, and the gallery is not yet finished. The difficulties which arise in the progress of it are very great, and the danger imminent. Avalanches of ice and immense stones fall about the works from the Mauvoisin side, and very much retard the efforts of the men. The ice itself is penetrated by water in every direction. Every aperture forms a fountain, and every stroke covers the workmen with water. On the 27th of May, violent noises were heard in the mass of ice, and some immense blocks rose up from the bottom of the lake. It was imagined the whole glacier would give way, and the men left their work. Nothing further, however, happened, and the men resumed their labours. Six days' labour remained on the 30th of May to complete the gallery, and the time was anxiously looked for, when the waters having a passage, the inhabitants might resign, in part, their fears of a sudden inundation. The gallery, when finished, will be more than 700 feet in length.

III. Natural History.

§ I. Zoology, Botany, &c.

1. *Zoophytic Animals.*

Mr. Lesueur, now in Philadelphia, made many curious observations on molluscous and zoophytic animals, during his passage from Europe to America. He collected and delineated the animals of many different species of Isis, Gargania, Alcyonium, Meandrites, &c., and obtained a beautiful series of Actinia, shewing the gradual transition into the animal Madrepore. His attention was also directed to the different vermes that occur, as well in the interior as on the exterior of fishes.

2. *Hoopoe.*

One of those birds, called the Hoopoe, exactly resembling that figured in Edwards's Gleanings of Natural History, was shot on the 2nd of May, by the game-keeper of the Earl of Mount Edgecumbe, near his Lordship's mansion. The bird is remarkable for a towering crest of long feathers, tipped with black, and though migratory, rarely occurs in this country. It is common in most parts of the Continent, and is found in the East Indies, particularly at Ceylon. It is usually of the size of a blackbird, but this was rather larger.

3. *White Spoon Bill.*

On Saturday 23d of May, a fine specimen of the Platalea Leucorodia, or White Spoon-bill, was shot on the river Yare, by a gentleman of Norwich. It measured two feet eight inches, and weighed three pounds and a half. The bill was seven inches long. The remains of a great number of shrimps were found in the craw.

4. *Osprey.*

A beautiful male bird, the Falco Haliætus of Linnæus, or Osprey, was shot in the middle of May, at Braydon, near Norwich. The bird is preserved in the Collection of Mr. W. Ayres, of Norwich. It is said also, that one of these birds was

shot at Brocklesly, in the early part of May, which measured five feet between the tips of the wings when extended.

5. *Pied Fly-catcher.*

That rare bird, the Pied Fly-catcher, (Muscicapa Abricapella of Linnæus) was seen last month in the woods below Chirk Castle, in Shropshire. The same bird was observed in the May of last year, near the same spot.

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§ II. Geology, Mineralogy, &c.

1. *New Mineral.—Hydrate of Silica and Alumina.*

M. Leon Dufour has found a mineral in the neighbourhood of Saint Sever, which appears to be new. It occurs in an argillacious gravelly soil, in detached pieces, from two to four or five inches in diameter. It is generally of a fine white colour, without lustre, but is found sometimes with the semi-transparency of opal. Its hardness is between that of limestone and lithomarga, and in many characters it approaches to the latter substance. Its fracture is dull; its composition homogenous. It is easily cut by a knife, and yet is singularly fragile: when struck by a hammer, it breaks into very angular pieces. It is soft to the touch, and may be polished very highly by friction. It adheres strongly to the tongue, but has no argillaceous or earthy odour, when breathed upon. It does not effervesce with acids, nor form with water a ductile paste. Its colour is not changed by heat. It has been observed to diffuse a very singular smell of apples, particularly when newly fractured.

An analysis, made by M. Pelletier, has given the constituents of 100 parts of this mineral, as silex 50, alumine 22, water 26, there being a loss of 2 parts.

2. *Siliciferous Sub-sulphate of Alumine.*

Dr. Henry, of Manchester, has described and analysed a peculiar substance, apparently the result of slow chemical action, found in the old hollows of a coal mine. It has exactly

the appearance, as well as consistency, of hogs-lard, and was mistaken at first for it by the miners. Its taste is sub-acid. It dries in the air, splitting like starch. When heated strongly, it becomes so hard as to stratch glass. An analysis gave its proportions as follows:

Water - - - -	88.1
Alumine - - - -	6.5
Sulphuric acid - - -	3.0
Silica - - - -	2.4
	1.00

It has been called siliciferous sub-sulphate of alumine.

3. *Sliding Mountain.*

A large portion of mountain, covered with rocks and fir trees, separated from the highest region, on the 4th of April, near the village of Soncebos, in the valley of St. Imier, in Switzerland, and covered with its stupendous wreck, more than 300 paces of the great road to Brienne. A few moments later, a party of travellers, who were witnesses of this terrific spectacle, would have been its victims.

4. *Fossil Remains.*

A considerable quantity of bones, of large size, were discovered last year, buried in the earth, in the neighbourhood of the village of Tiede, near Brunswick. They were examined by M. Dahne, who appears to have distinguished parts of the skeletons of five elephants. There were nine tusks among them, one of which was 14 feet in length, another 11, and many grinders, in which the enamel was arranged exactly as in the teeth of the African elephant. A complete head of a rhinoceros, with the horn and teeth, was also found very little altered, and likewise the horns of two kinds of stags.

These bones were found on the summit of a hill, in a bank of clay soil, from 15 to 20 feet in thickness. They were discovered in working a stone quarry under the clay stratum, by M. Berger, of Brunswick. They are not at all altered, except

in the loss of organized animal matter, and were lying in a scattered and confused manner in the earth.

M. Dahne, in endeavouring to account for this accumulation of bones belonging to different animals, supposes that the animals existed in immense islands; that some great revolution of the globe inundated their habitations, and forced them to the highest spot for shelter from the waters, that the waters still rising, they all perished together, that the perishable parts of their carcases were carried away by the waters, and that an earthy deposition soon enveloped the bones, and left them nearly in the state they are now found.

5. *Embedded Diamonds.*

An aggregate substance has been found in the Diamond Mines on the banks of the river Iigitonhōnha in Brazil, containing or enveloping diamonds, gold, iron, &c. The rock consists of an aggregate of small quartz pebbles, firmly set in indurated iron sand; but it is doubtful whether this be the true matrix of the diamond, or only a consolidation of particles around it.

6. *Zircon.*

This mineral has, we understand, been discovered by Dr. Mac Culloch, in Sutherland. It occurs in a compound rock, formed of copper coloured mica, hornblende, and felspar. This rock forms one of the occasional beds in the gneiss, and bears a resemblance in its composition to the zircon syenite of the north of Europe; the crystals, a quarter of an inch in length, are well defined, and their colour is an obscure crimson, approaching to that of cinnamon.

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§ III. Anatomy, Medicine, &c.

1. *Anatomical Prize Question for* 1819.

The annual prize of 300 francs, founded by M. Alhumbert, is to be awarded in the ensuing year by the Academy of Sciences at Paris, and they have in consequence announced that they will give a gold medal of 300 francs value to the author of the best

anatomical description of those intestinal worms, known under the names of Ascaris lumbricalis, and Echinorhynchus gigas. One object of the author should be to ascertain whether these animals have nerves and blood vessels, or not.

The papers are to be sent to the Secretary of the Academy, before the 1st of January 1819.

2. *Newly discovered Membrane in the Eye.*

24, Aungier Street, Dublin, June 13, 1818.

Doctor Jacob, Demonstrator of Anatomy in the University of Dublin, has discovered, and demonstrated in his lectures on the diseases of the eye, this spring, a membrane covering the external surface of the retina, in man and other animals. Its extreme delicacy accounts for its not having been hitherto noticed. He arrived at the discovery by means of a new method of displaying and examining this and other delicate parts. He argues from analogy, the necessity of the existence of such a membrane, as parts so different in structure and functions as the retina and choroid coat must otherwise be in contact, in contradiction to the provisions of the animal economy in general. A detailed account of the discovery, with the method of displaying the membrane, is in preparation, and will shortly be laid before the public.

3. *Medical Prizes for* 1820.

The Medical Society of Emulation at Paris, has proposed to adjudge two prizes, each of five hundred francs value, to the authors of the best dissertations on the following questions.

" What are the advantages which medicine has derived from military and naval practice, since the commencement of the wars of the revolution, down to the time of the general peace?"

" What are the particular conformation, tendencies, and functions of that system of organs named the nervous ganglia of organic life, the great sympathetic nerve, the great intercostal, the trisplanchnic (trisplanchnique), &c.? And what are the maladies, as far as it is possible to ascertain them, in which this system of nerves is essentially?"

The dissertations must be written in French or Latin, and sent

free of postage, before 31st August 1819, to M. Breschet, Secretary to the Society, Rue de la Jussienne, No. 17, à Paris.

4. *Use of Tar in Pulmonary Consumption.*

Experiments have lately been made on the use of the vapour of tar in pulmonary consumption, and, it is said, with very favourable results. The following is the method recommended, With each pound of tar (such as is used in the cordage of ships), mix half an ounce of cream of tartar, heat the mixture in a sound vessel, and be careful that no combustion of any portion of the tar takes place, but merely an evaporation. The vapour may then be inhaled for several hours together. It at first sometimes occasions head-ache, but this soon goes off, and the good effects become in some days evident.

5. *On the Use of distilled Sea-water.*

Some very extensive experiments have been made in France on the use of distilled sea-water in the preparation of food, and as a beverage, and they have afforded favourable results. The men upon whom the experiments were made, were principally criminals, and for the most part galley slaves at the ports of Brest, Toulon, Rochefort, &c. Most of the individuals knew that they were drinking nothing but distilled sea-water, and that a suspicion was entertained of some particular effect belonging to it, but some were not aware of the trials made upon them. They were dieted in the way that seamen are, with the exception of two meals of fresh meat per week.

Some of the men complained of pains in the bowels and diarrhœa, and others suffered under various slight indispositions; the complaints however appeared to be without cause, and the real indispositions, from their removal without changing their mode of living, were shewn to be casual and not dependant upon the water. The health of many of them appeared to be improved during the time they remained subjects of trial.

The individual experience of intelligent persons has also confirmed the favourable conclusion drawn from the above experiments, and in no case has it been found to possess the sharp taste or caustic qualities ascribed to it.

The inference drawn by the Commissioners who were appointed to ascertain the effects arising from the constant use of distilled sea-water is the same; they all conclude that it may be employed both in cooking, and as a beverage, for a month at least, without any injury to the health. The presumption is, that it may be used nearly as good common water, and that it affords a resource which at times may be of great importance; as in long voyages, and particularly in those of discovery.

6. *Medical Properties of Salt.*

The importance and value of salt as an introduction unto food, becomes continually more evident, as its medicinal properties are rendered more distinct and fully known. Among other salubrious virtues, may be mentioned its anthelminthick properties, which have been rendered very evident by the publication of some late cases. It appears that whenever salt is denied to the human being, diseases of the stomach are general, and that worms are engendered in the body; and in one instance, where a person, from aversion to that substance, had refused it either in food, or in any other form, they appear to have been the consequence, and remained for many years.

In Ireland, salt is a well known common remedy for *bots* in the horse; and among the poor people, a dose of common salt is esteemed a cure for the worms.

IV. General Literature, and Miscellaneous Intelligence.

1. *British Museum.*

From the annual returns of this Institution, it appears that its total receipts for the year ending 25th of March, 1818, were £12,455. 12*s*. 5*d*. and its expenditure £11,724 9*s*. 1*d*. leaving a surplus in hand of £731. 3*s*. 4*d*. A quantity of duplicates which are about to be sold, are expected to produce the sum of £1000. which sum has been engaged for the purchase of the Ginguéné Library, at Paris. The duplicates of Dr. Burney's Library, which cannot be sold before the year 1819, are expected to produce a sum of between three and four thousand

pounds, and will be brought into the account as a deduction from the parliamentary grant for that year. The number of persons admitted to view the Museum during the last year, was 50,172, being nearly double the number admitted in 1812.

2. *Pompeia, Herculaneum, &c.*

The idea that Pompeia and Herculaneum were destroyed by an eruption of Vesuvius in the year 79, has been very generally received. A new opinion however has been advanced respecting the destruction of these two cities, which attributes it to a rising of the waters of the sea, and a deposition of finely divided matter from them. It is asserted that a formation similar to that which covers Pompeia is daily forming on the shores at Naples, and that Herculaneum is covered by a mass of tufa, and not by lava. There is little doubt but that Herculaneum has been buried in consequence of the action of water, but whether by a wave of the sea, or by torrents thrown out from the volcano, is more uncertain. Pompeia has probably been covered by a gradual fall of ashes.

3. *Herculaneum MSS.*

Dr. Sickler's endeavours to unroll the Herculanean MSS. completely failed, so that as yet no great approach has been made towards a knowledge of the contents of these remains of ancient literature. Sir H. Davy intends whilst abroad, to examine minutely the state of these rolls, and to ascertain whether chemical agencies may not be importantly applied in facilitating their developement. There can be no doubt but that some important results will be gained.

4. *Model of Roman Measures.*

A model was found in the year 1816 in the excavation at Pompeia, of some ancient Roman measures, and a description of it has since been published in the Italian Journals. It was supposed to be either the mold or the pattern of a public measure, and consisted of two oblong tables of tufa, placed the one on the other, with lateral supports of the same stone. In the upper surface of the first table, which was 8½ palms long, and 2½ wide, five circular cavities of various dimensions had been formed in a right line; in the bottom of each cavity was a small hole, which could be shut by a small piece of brass when-

ever it was necessary, and opened after measurement for the purpose of drying the measure. In the four corners of the same table were cylindrical holes, much smaller than those described, and having apertures not made through to the bottom, but sideways, in a transverse line.

This instrument is considered as a standard measure for liquids, and the Italian antiquary has concluded, from some pieces of lead fastened into the end, and which are supposed to be the remains of hinges, that each of the larger cavities had a cover fitted to it. There were five inscriptions on the under side of this model, but so much effaced that they could not be read. It is supposed, that they were the names of the six larger measures. An inscription remains on the front of the stone, which informs us that *Aulus Clodius Flaccus, son of Aulus, and Narcius Arellius Caldus, son of Narcius, duumvirs of justice, were ordered by decree of the Decuriones, to equalise the public measure.*

It is somewhat singular, that the Romans, who were so careful of every thing concerning the duration of public property, should have chosen so bad a material for the formation of this standard, as tufa.

5. *Roman Station.*

About seven miles east of Grantham, in the parish of Haceby, by the bridge and turnpike, on the side of a hill commanding a view of Boston Haven, were lately discovered, very considerable remains of ancient buildings, tessellated pavements, and other indications of a fixed military station of the Romans. Already various apartments have been laid open, and a high treat afforded to antiquaries, who are daily flocking to the spot. Tessellated pavements, belonging to three distinct apartments near the road, have been uncovered, and as the work of slow and careful search proceeds, similar ingenious and beautiful pavements are beginning to make their appearance at some distance on the south-west side of the field. One of the apartments is a sudatory (or sweating bath) the flue and furnaces of which are very distinct. Sir Joseph Banks, and other competent judges agree in opinion,

that it is the *Causennis* of the Romans, which has been discovered. The place has, from time immemorial, been called the Roman Hill, but nothing had been before discovered to fix a belief of it having been occupied by that people. The *Causennis* was formerly supposed to have been at Bridge Costerton, but the discovery of these remains have now destroyed that opinion.

6. *Temple of Castor and Pollux.*

Excavations have been made by the Count de Blacas, around the antient temple of Castor and Pollux, at Rome; and already many fragments of the *fastes consulares* have been discovered. The object of the excavations is a knowledge of the plan of the building, and it is entrusted to the care of M. Caristy, of the French Academy.

7. *Antient Sepulchre.*

The French papers give an account of a very interesting piece of antiquity discovered near Chiusi, by a peasant, whilst digging in a field on the 5th of last February. It consisted of a sepulchral chamber of a rectangular form, near seven fathoms long and five broad. The entrance door has two folds, which turn freely upon their hinges. Eight funeral urns, ornamented with human heads and foliage, were found in the interior in fine preservation, and upon the edges of the covers are engraved several Etrurian inscriptions, many of which are perfectly distinct. Five of the urns are smaller than the rest, and variable in size. They all contained ashes, and the remains of burnt bones. The whole chamber was in good preservation, and great care has been taken to preserve it from injury.

8. *Remains of an ancient Building at Paris.*

The remains of an ancient building of large size, were lately found in a garden of the Faubourg de Perigueux, at Paris; the ruins appear to extend beyond the garden beneath the road which is next to it, and far into a field on the opposite side. They consist of pavements, bricks, broken walls, marbles, and other antiquities of this kind. The most remarkable is a

pavement 24 feet by 12, ornamented in the middle by a piece of rough mosaic work, in bad taste, surrounded by a stucco floor. Some small articles in metal, as two medals of Constantine the younger; a bronze die, intended apparently to strike a small ornament, &c. have been found. It is not supposed that the place was built before the fifth century.

9. *Ancient Sarcophagus.*

A stone sarcophagus has been forwarded to the Asiatic Society, which was dug out of the foundation of some ancient ruins, about eight miles from Bushire. It contained, when discovered, the disjointed bones of a human skeleton, perfect in their shape, but they broke down in a short time after their exposure to the atmosphere. The vessel is of calcareous sandstone, the lid of a micacious rock, and it was fastened down by metallic pins. This is the second of the kind which has been discovered. Those which are usually dug up, are of baked clay, and it is concluded, that these rarer kind contain the remains of eminent personages.

10. *Ancient Mausoleum.*

A mausoleum, in complete preservation, has been lately discovered at Hyeres, in France. It is three metres long, and two wide; is in white mosaic, and contains a dolphin and an urn in blue mosaic. By the side of this mausoleum, was also found another of a similar kind.

11. *Antiquities at Avignon.*

Some ancient monuments, in a very grand style, have been discovered lately in digging up the ground in the square on which the town-hall stands at Avignon. Magnificent columns have been found, 15 feet below the surface. The excavations are continued with great activity. It is supposed, that these columns have been buried since the time that Domitius Oenobarbus, in the year 619 of the Roman Republic, destroyed the Vindalium, a fine city of the Gauls, from the ruins of which arose Avenio.

12. *Ancient Amphora.*

April. Some labourers digging gravel on the road leading to Wimpole, in Cambridgeshire, discovered in an old Roman tumulus about fourteen inches below the surface of the earth, a stone slab which covered the mouth of a large *amphora* full of water; in which was found a black vase of terra-cotta about half filled with human bones; and also two smaller vessels of red terra-cotta with handles.

13. *Ancient Coins.*

Forty-six shillings, scarcely injured by time, of the early part of the reign of Queen Elizabeth, were discovered in a small silver box in the middle of April, by a man while ploughing a piece of ground at Oxcomb, near Louth in Lincolnshire.

A gold coin of the value of eighteen shillings of the reign of Julius Cæsar was dug up a few weeks since by a servant of Mr. Johnson at Tenterden in Kent, and is in tolerable preservation.

A copper coin of the reign of the Emperor Alexander Severus was dug up in the beginning of last month by the workmen whilst making the inclosure nearest to the Pavilion at Brighton, which is to be called the Regent's Steyne.

In excavating the site of a very ancient house in Wade Lane, Leeds, belonging to Mr. R. Kemplay, the workmen discovered a quantity of ancient coins. They were found loose in the earth about two feet below the surface, and appear to have been placed there previous to the erection of the building. As the building was one of the most ancient in the place, it is judged the coins must have been there many hundred years; they are of copper, or as is supposed by some of Corinthian brass, and so much injured by time that the inscriptions are extremely imperfect. The impression is a crowned head, which though nearly similar on all of them, is not exactly the same; the reverses are various, some having a female figure, others that of a man, and varying in attitude. They are

probably early Roman coins, and one appears to be of the time of the emperor Otho; but how they became deposited in their late situation is difficult to conjecture.

14. *Antique Gold Ring.*

A massy gold ring, three-quarters of an ounce weight, was found last month in cutting the new road at Stanwix, with a number of characters similar to those on the pillar in Newcastle church yard.

15. *Puget's Head of the Saviour.*

The head of the Saviour, the *chef-d'œuvre* of Francis Puget, the celebrated French sculptor, has accidentally been discovered at Marseilles. It belonged to one who knew nothing of its value, and who had given it to a workman to clean. It was suffered to lie unregarded in the shop until accidentally examined by a Roman sculptor (Canova?) who recognised it. Puget began this head at the age of thirty, and devoted ten years of labour to it.

16. *Mosaic Art.*

The art of working in mosaic, though entirely unknown here as a practical study, holds a high rank among the Italians in the fine arts; and the various cities of that part of Europe vie with each other in the production of superior works and distinguished masters in this branch of design. The following observations are taken from the Biblioteca Italiana (of Milan) they are contained in the review of the Arts and Sciences for 1817, and will convey an idea of the importance and interest attached to mosiac work by the Italians.

"In Mosaic work also we are able, since Professor Raphael has resided here, to come in competition with Rome itself: he is perfectly acquainted with a method of making coloured pastes, which is unknown to any but his family, even to the Roman artists themselves. This professor is the first who has rendered the execution of very minute objects possible; by means of his spun paste *(paste filate)* he emulates by the mosaic art the finest touches not only of the picture but the miniature. Praise ought also to be given to another improvement of this art, which consists in a better method of

laying down the first design and in filling it up, so that the lines shall remain undisturbed and correct. In the Roman school, by striking and compressing the pieces they are moved backwards and forwards in all directions, and their accuracy much diminished.

This school has already pupils of great merit, among which may be named the son of Signor Raffaelle, Ruspi Morelli, Banfi Pizzamano, Migliavacca, and many others. It will be sufficient in confirmation of the commendations which it deserves, to observe that the largest work of this kind since the restoration of this art in Italy, has been undertaken and successfully completed in an admirable style of workmanship, and in a very short time, at Milan. This is the famous Supper of Leonardo da Vinci. It is 15 braccia by 7½, which is above 29¼ feet by 14⅝, and is nearly one-third larger than the largest in St. Peters at Rome."

Art. XXII. Meteorological Diary for the Months of March, April, and May, 1818, kept at Earl Spencer's Seat at Althorp, in Northamptonshire. The Thermometer hangs in a north-eastern aspect, about five feet from the ground, and a foot from the wall.

METEOROLOGICAL DIARY
for March, 1818.

		Thermometer.		Barometer.		Wind.	
		Low.	High.	Morn.	Even	Morn.	Even.
Sunday	1	35	41	29,38	29,40	SW	SW
Monday	2	33	47	29,48	29,40	SW	SW
Tuesday	3	32	48	29,58	29,36	SW	SW
Wednesday	4	33	44,5	29,17	29,00	SW	SE
Thursday	5	37	42	28,67	28,80	W	SW
Friday	6	34	46	29,00	29.20	WbS	WbS
Saturday	7	32	48	29,10	28,60	S	SW
Sunday	8	37	45	28,72	28,98	SW	W
Monday	9	31	38	29,18	29,20	SW	W
Tuesday	10	27	39	29,20	29,16	W	WbS
Wednesday	11	31	42	29,28	29,23	WbS	WSW
Thursday	12	30	41	28,70	28,80	W	WbN
Friday	13	32	41,5	29,18	29,52	NE	NW
Saturday	14	30	45,5	29,66	29,62	W	SW
Sunday	15	37	44,5	29,34	29,10	SE	S
Monday	16	33	45	29,18	29,48	SW	W
Tuesday	17	37	48	29,50	29,79	WSW	W
Wednesday	18	34	52	29,88	29,84	W	W
Thursday	19	37	49	29,80	29,65	W	SW
Friday	20	44	50	29,50	29,70	NW	W
Saturday	21	31	48	29,78	29,64	SW	SW
Sunday	22	36,5	47	29,47	29,40	WSW	WSW
Monday	23	43	46	29,07	29,40	WSW	WSW
Tuesday	24	31	46,5	29,50	29,53	SW	WbN
Wednesday	25	33	45	29,40	29,63	WSW	WNW
Thursday	26	30	38	29,49	29,20	SE	NW
Friday	27	29,5	43	29,87	30,10	W	N
Saturday	28	31	42	30,17	30,11	SW	SSE
Sunday	29	37	46	30,03	29,97	SE	SSE
Monday	30	38	51	30,00	30,09	SSE	WNW
Tuesday	31	32	46	30,21	30,20	NE	NE

METEOROLOGICAL DIARY

for April, 1818.

		Thermometer.		Barometer.		Wind.	
		Low.	High.	Morn.	Even.	Morn.	Even.
Wednesday	1	35	44	30,19	30,16	NNE	NE
Thursday	2	36	46	30,20	30,22	E	NE
Friday	3	36	43	30,25	30,33	NE	NE
Saturday	4	35	45	30,33	30,16	E	E
Sunday	5	26	49	29,97	29,64	SW	SSW
Monday	6	40	52	29,20	29,33	SSW	WNW
Tuesday	7	37	39	29,59	29,42	NW	E
Wednesday	8	34	59	29,30	29,21	WSW	SW
Thursday	9	47	53	29,17	29,17	SW	SW
Friday	10	41	51	29,41	29,20	SW	ESE
Saturday	11	43	49	29,08	29,23	SW	NE
Sunday	12	30	46	29,87	29,93	NW	SW
Monday	13	28,5	48	29,93	29,70	WSW	SSW
Tuesday	14	33	54	29,58	29,58	SE	SSW
Wednesday	15	35	55	29,60	29,50	SSE	E
Thursday	16	34	54	29,39	29,22	ENE	ENE
Friday	17	42	55	29,21	29,21	ENE	ENE
Saturday	18	37	49	29,27	29,43	ENE	ENE
Sunday	19	29	49	29,60	29,65	ENE	ENE
Monday	20	29	50	29,70	29,65	ENE	ENE
Tuesday	21	26,5	52	29,60	29,60	SSE	ESE
Wednesday	22	36	48	29,61	29,50	E	ENE
Thursday	23	39	40	29,44	29,42	E	E
Friday	24	38	41	29,24	29,24	NE	NE
Saturday	25	37	45	29,08	29,10	NE	NE
Sunday	26	41	55	29,32	29,35	E	E
Monday	27	49	61	29,24	29,40	E	S
Tuesday	28	42	58.	29,60	29,80	S	SW
Wednesday	29	32	60	29,85	29,80	SW	ESE
Thursday	30	38	49	29,70	29,47	ENE	ENE

METEOROLOGICAL DIARY

for May, 1818.

		Thermometer.		Barometer.		Wind.	
		Low.	High.	Morn.	Even.	Morn.	Even.
Friday	1	47	59	29,50	29,70	W	SW
Saturday	2	34	61	29,75	29,68	WSW	E
Sunday	3	43	53	29,50	29,37	E	E
Monday	4	44	63	29,40	29,40	W	WbS
Tuesday	5	45	62	29,40	29,30	W	W
Wednesday	6	47	55	29,27	29,20	EbN	SE
Thursday	7	43	59	29,20	29,30	S	SW
Friday	8	39	60	29,42	29,43	SW	E
Saturday	9	47	61	29,40	29,50	WSW	SW
Sunday	10	40	63	29,70	29,70	SW	SE
Monday	11	46	64	29,62	29,50	SE	S
Tuesday	12	44,5	65	29,50	29,52	W	WSW
Wednesday	13	40	58	29,43	29,24	E	WSW
Thursday	14	42	54	29,24	29,30	E	SE
Friday	15	44	61	29,41	29,41	SW	ENE
Saturday	16	45	58	29,44	29,50	WSW	SW
Sunday	17	48	57	29,60	29,68	NNE	NE
Monday	18	39	66	29,80	29,84	NW	NE
Tuesday	19	45	57	29,90	29,93	NE	NE
Wednesday	20	36	60	29,98	30,00	NE	NE
Thursday	21	45	56	30,08	30,10	NE	NE
Friday	22	33	57	30,13	30,13	NE	NE
Saturday	23	34	60	30,20	30,19	NE	NE
Sunday	24	35	64	30,24	30,24	NE	ENE
Monday	25	42	60	30,24	30,20	E	ENE
Tuesday	26	46	62	30,20	30,20	ENE	ENE
Wednesday	27	45	59	30,23	30,20	NE	NE
Thursday	28	42	68	30,17	30,09	NE	NE
Friday	29	43	56	30,09	30,09	NE	NE
Saturday	30	44	60	30,09	29,97	NE	NE
Sunday	31	40	67	29,90	29,87	NW	NNW

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London: Printed by W. Bulmer and Co.
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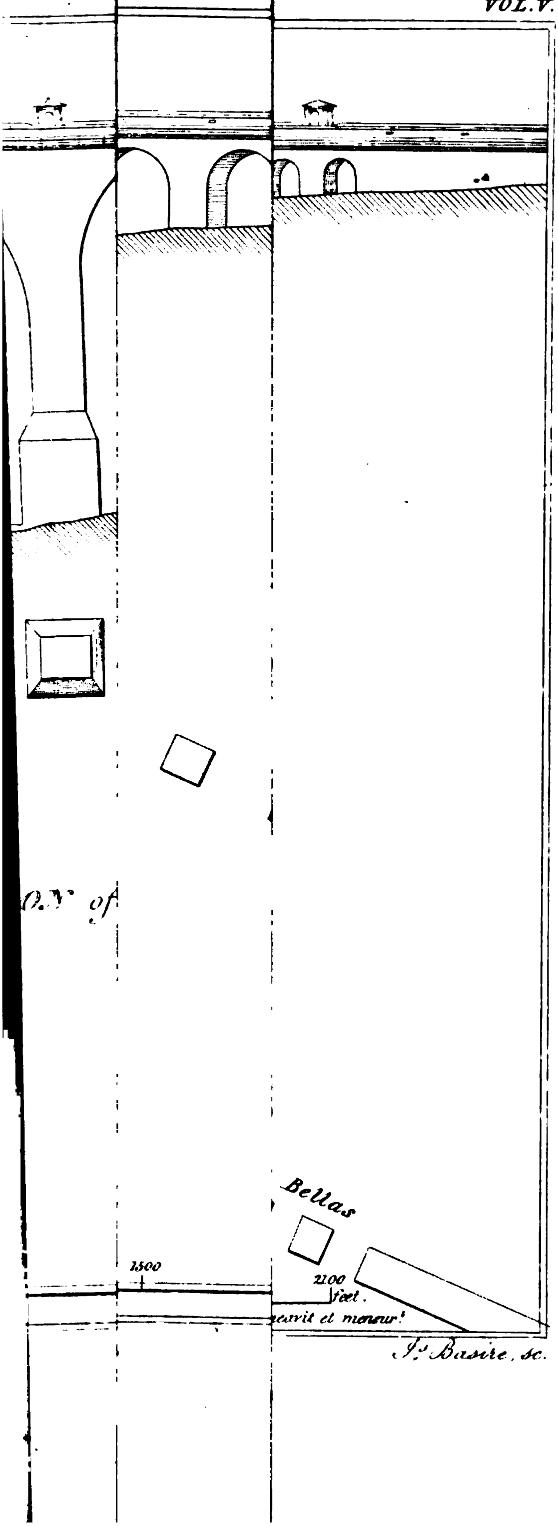

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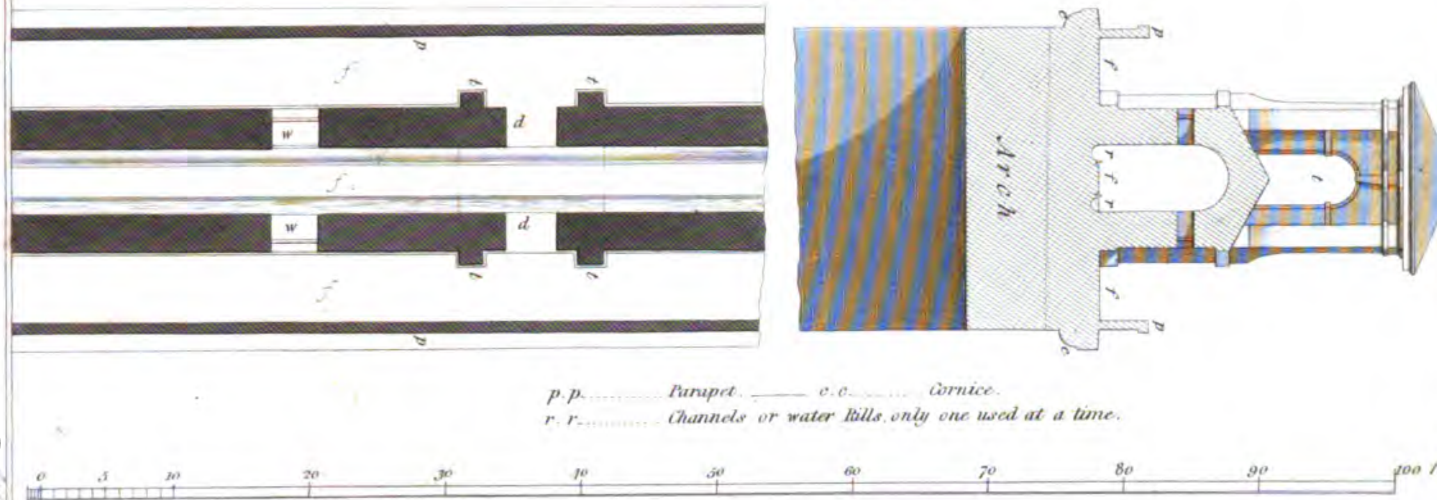

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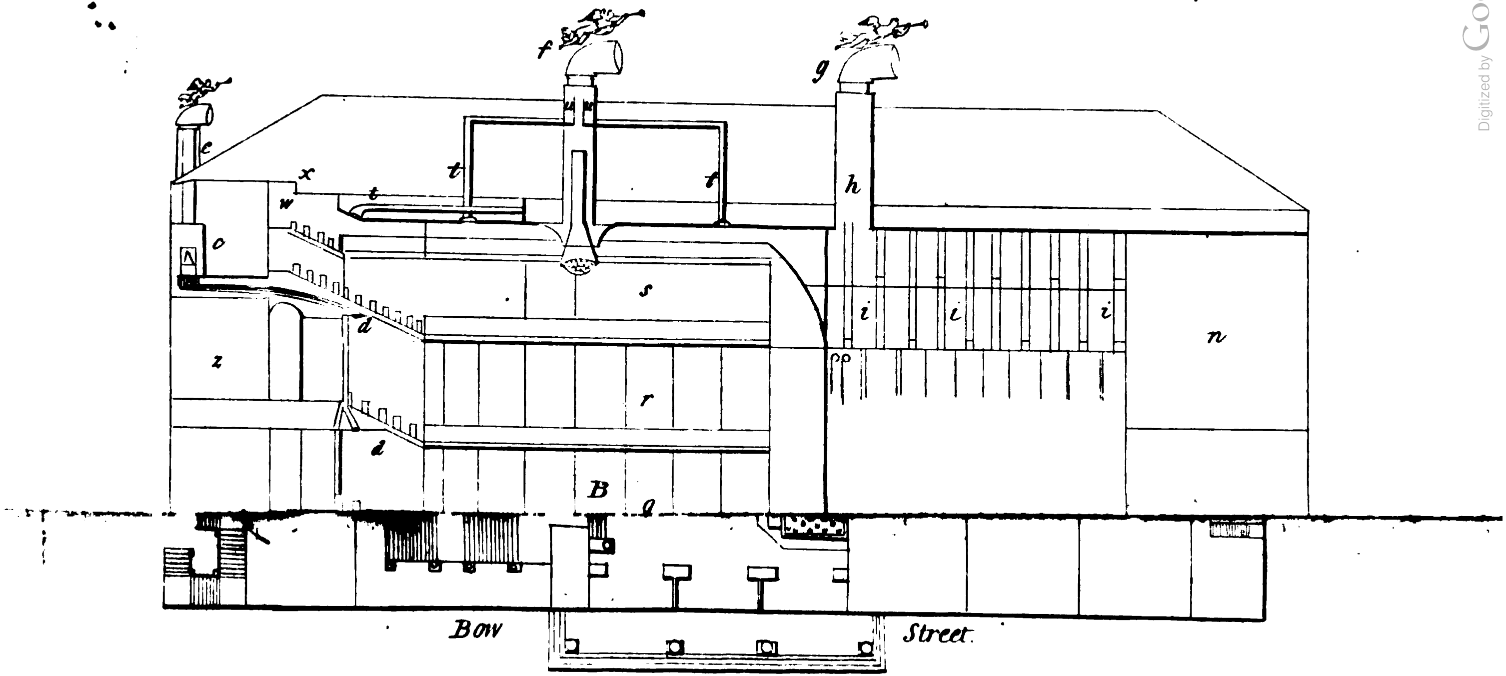
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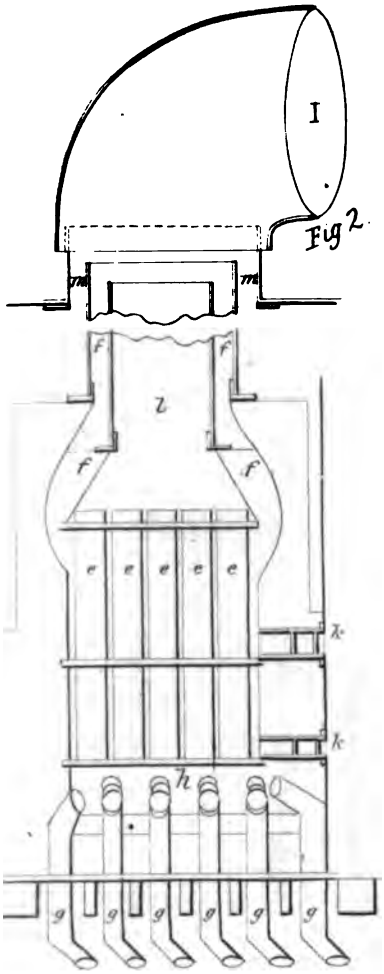

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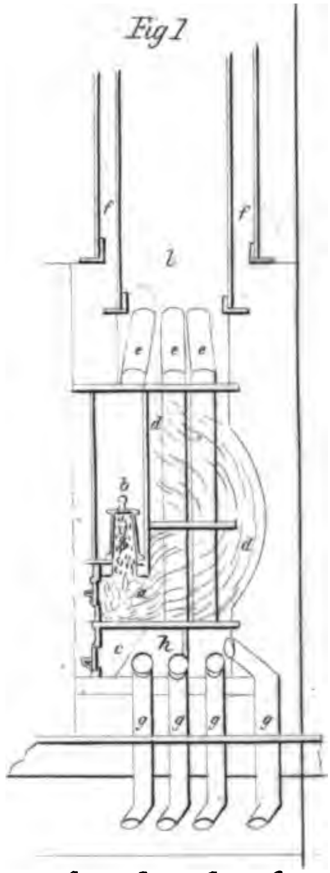

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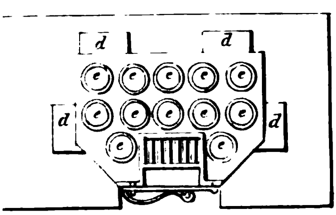

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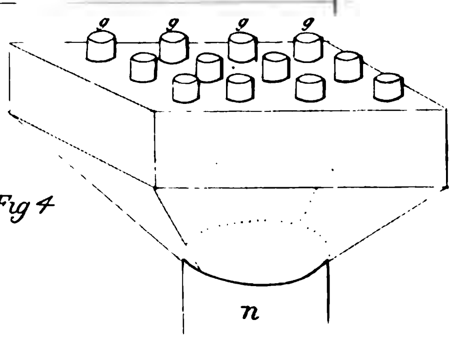

Fig 4

PL. VIII.